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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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MEN, with knowledge of English; preference given to those with Engineering experience. State age and experience. No one on Government work will be engaged.—Apply, your nearest LABOUR EXCHANGE, quoting No. A 2318. F 66

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with Firm (Government Contractors) manufacturing latest types of machinery, oil and gas engines, &c.; moderate premium.—Address, 6021, Offices of ENGINEERING.

A Large Firm of Engineers,

in the Midlands, have an OPENING for a YOUTH of good education as premium pupil, the course to include both works and drawing office.—Address, 4389, Offices of ENGINEERING.

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Engineer, Specialist in the

design and construction of oil-burning installations, the complete conversion of ships for carrying and burning liquid fuel, and expert power engineer, is OPEN to an ENGAGEMENT in the above capacity with an oil fuel company, steamship company, or similar responsible concern. He is prepared to guarantee great saving in capital outlay and the most efficient operation, and to accept part remuneration on results obtained if desired. A high and responsible appointment only entertained.—Address, F 86, Offices of ENGINEERING.

An A.M.I.C.E., Disengaged,

ineligible for the army, SEEKS POSITION public works construction.—Address, F 115, Offices of ENGINEERING.

Engineer, Disengaged, Pro-

gressive with prof. and practical training in various branches, including aircraft SEEKS POSITION as Works or Assistant Manager, &c.—Address, F 103, Offices of ENGINEERING.

Engineer, Experienced Marine

internal combustion and other work, accustomed responsibility and control, works organisation, designer, draughtsman, and C.S.; would consider suitable opening on War work. Any district.—Address, F 112, Offices of ENGINEERING.

Employment Wanted by En-

gineer (34). Has been ratefixer, engine and jig and tool draughtsman in large works, and over shops and D.O. in small works. Aero and auto engines and general work. References testify to success. Salary about £300.—N., 2, Cedar Road, Teddington. F 113

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Practical and organising. Fitting, erecting, machining. Some electric. Thorough knowledge munitions, inspector Royal Arsenal and U.S.A. steel and machine works. Office and sales.—Address, F 121, Offices of ENGINEERING.

Business Man (42), Mechanical

and constructional experience, used to handling men in building, constructional, and mechanical operations, thorough knowledge of internal combustion engines, construction, repairs, and installations, experienced in V bottom speed boats. WANTS responsible POSITION with firm during war.—F. D. care of F. DODSON & Co., Brokers, Vancouver, B.C. F 93

Wanted, Situation as Ware-

houseman or Storekeeper, 12 years' experience in railway shop stores. Good Storekeeper; Receipts and Issues, and General Stores Routine. Ineligible for Military Service. Good references. Advertiser desirous of change. Interview if desired. Address, E 973, Offices of ENGINEERING.

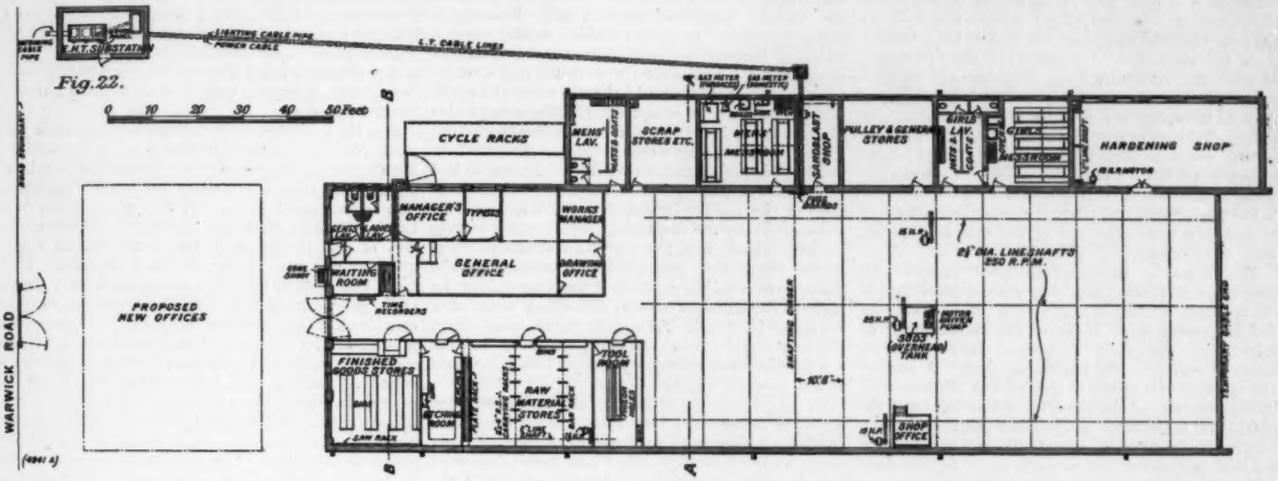
THE ARRANGEMENT OF MACHINE SHOPS.—No. V.

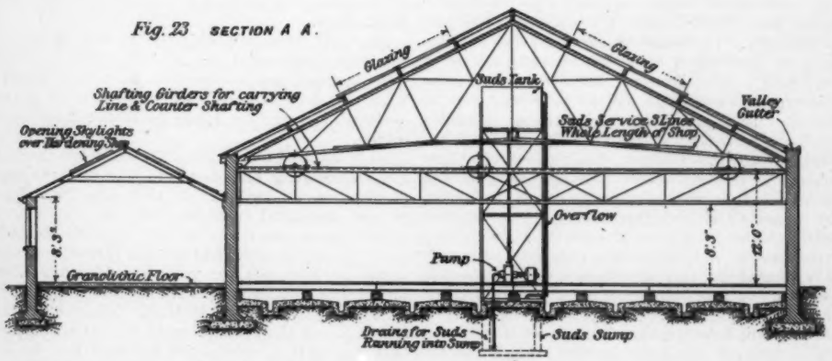
By JOSEPH HORNER.

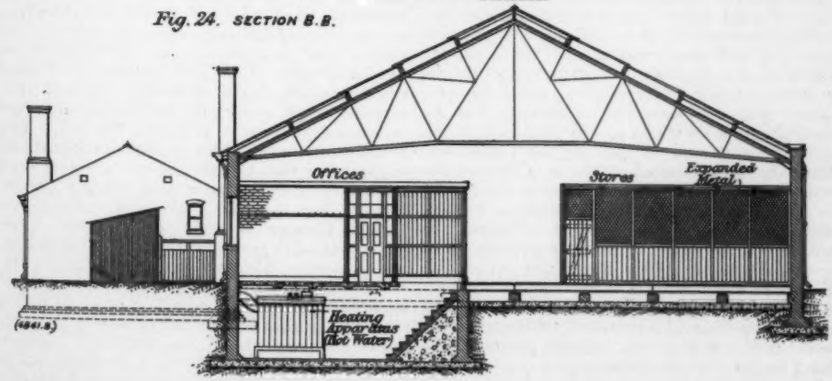
THE illustrations on the present page and on page 282 are those of a new machine shop now in process of erection and equipment but not yet completed, for which a site of about six acres had been acquired. The conditions by which the firm—the Brooke Tool Manufacturing Company, Limited—have been hampered were those outlined in our first article. The firm's original shops, in Belgrave-road, Birmingham, were much too small for their rapidly-growing business. They have cut the knot by getting away from the straitened surroundings into a comparatively rural district—the Warwick road, alongside the River Cole. This district is now being developed by the Town Planning Department, and it also has the advantage of being in close proximity to Tyesley, which is another growing industrial centre. Here, with six freehold acres in their possession, the firm have built the first portion of the new works (illustrated by Figs. 22 to 24) on the ground-floor system, and have about 160 workpeople and staff in the shops, which are running day and night.

The articles which are manufactured by the firm are of an entirely light character, comprising metal-slitting saws, milling cutters, hobs, reamers, and engineer's small tools generally. No crane services, therefore, are required. And while a firm in a congested district would adopt a multi-storied design of building for this class of work, the Brooke Tool Manufacturing Company, having generous space at its disposal, prefers the single-floor design, which is also favourable for supervision. The present works consist of one main building, 200 ft. long by 60 ft. wide, with a bay, 20 ft. wide, extending along the whole of one side. In this are located the various departments which have to be separated from the main manufacturing operations performed by the machine tools. These are denoted by the descriptions on the plan view, Fig. 22.

Within the main floor certain portions are partitioned off at the entrance end of the building, as shown by the plan view. These include the various offices occupied by the staff, which have timber partitions for the time being. At the other side of the entrance passage are partitioned off the finished stores, the tool room, and the etching room in which tools are marked, stamping being avoided as liable to distort the tools. By examining the section, Fig. 24, taken on B–B, it is seen that while the upper panels of the offices are of glass, expanded metal is used in the finished goods stores. Provision for rapid extension to the offices is made by having the timber partition work in sections of uniform sizes and easily removable, so that the dimensions of any of these departments can be readily increased, or lessened if need be. It must be remembered that as work presses these are regarded as being probably temporary arrangements. Ultimately when the growth of the business warrants it, a separate block of buildings will be put up for offices and stores. Then the space which these departments now occupy will be thrown into the machine-tool area for manufacturing purposes solely, and the partitions will all be utilised in the new buildings.







The works are motor-driven, but line shafting and countershafts are employed. There are three lengths of line shaft in the main building, running at 250 r.p.m. Special light girders, spaced at 10 ft. 6 in. centres, span the shop to carry the line and counter-shafts. The latter are slung from timber beams, measuring 7 in. by 3 in., which rest on any two adjacent shafting girders. All the beams and hangers are hook-bolted or clipped together, so that no drilling was necessary during the erection. This effected a great saving in time while the plant was being moved from the old works to the new, permitting the output to be maintained while the removal was in progress. These beams are seen to the right in Fig. 25, page 282, resting on the light lattice girders which span the shop. One of the main line shafts is seen in the centre. This view, looking down on the shop from underneath the roof, and the next (Fig. 26, page 282), taken from the floor, may be compared for details of driving and of machine dispositions.

The location of the motors for the line shafts is seen in the plan view (Fig. 22). The power and the lighting question have been solved by taking a three-phase supply of 5,000 volts, 25 cycles, from the Corporation mains. A step-down transformer is used, giving 440 volts for power, and 110 for lighting. The transformers, motors and switch gear were all supplied by the British Westinghouse Electric and Manufacturing Company, Limited, and all the motors are of the squirrel-cage type. The lighting in the main building is carried out by a hundred ½-watt lamps uniformly distributed, and attached to the undersides of the shafting girders, the wire passing through them. By adopting this method no trouble has been experienced from breakages, as the lamps are well out of the way. The intensity of illumination is approximately 1.3 c.p. per square foot. As all the materials in the building, with the exception of the actual machines, are painted white, a

very uniform light is obtained, and one entirely free from shadow.

An arrangement which is of a very interesting and as yet unusual character is the systematic provision that is made for lubrication. Instead of the gravity drip-can of the old days, or the needless multiplication of pumps employed in the system of making each machine self-contained as regards lubrication, a system of pipe lines is installed, distributing the suds to each machine from an overhead tank. This is seen in the plan view (Fig. 22), and in the section taken on A–A (Fig. 23). It is served by a 2.5 h.p. electrically-driven centrifugal pump, which draws the suds from the sump into which they have drained from the machines. The pipes run the full length of the shop, and from them branches are dropped down to the machine tools. The suds find their way back to the sump below the head tank (Fig. 23) by means of channels, seen also in this view, constructed in the concrete under the timber floor; these channels all fall towards the sump. To make the drain connection it is only necessary to bore a hole in the timber floor and put the machine drain through it, and then there is no risk of the suds not getting back to the sump.

The machine tool arrangements provide for progressive manufacture. The work consists mainly of turning, milling and grinding, with hardening and tempering done in one of the buildings in the side bay. The work progresses from the raw material stores to the hardening shop. A part of the raw material stores is seen in Fig. 27, page 282, illustrating one of the racks for round bars, and the cutting-off machines. Benches are placed at intervals in the shop for the viewers, the articles stopping for that purpose at the bench next to the machine which they have just left. Some of these are shown in Fig. 28. Girls, who use micrometer gauges, &c., are largely employed as viewers. Each machine is equipped with its own tool stand and useful tables are distributed as shown in Figs. 25 and 26, page 282.

The buildings have brick walls, and a ridge roof with broad skylights. There are no windows in the walls, except at the offices and in the side bay. The shop floor is of wood, supported on concrete, with a clear space between, as shown in Fig. 23. The hardening shop has a hard granolithic floor. The buildings are heated with low-pressure hot water, the apparatus being beneath the offices (Fig. 24). Some of the pipes are seen in Fig. 25. Numerous details in the buildings will be understood from the descriptive lettering. A temporary gable at one end would only have to be removed to permit of the extension of the shop in that direction. As previously remarked, no hoisting machinery is required for handling the articles produced; light trucks, without shop tracks, provide all necessary requirements for handling and transit.

THE BRITISH ASSOCIATION.

(Continued from page 249.)

SECTION G.—ENGINEERING.

FUEL ECONOMY.

BOTH the morning and afternoon meetings on Friday the 8th inst. were devoted to a joint discussion with section B on Fuel Economy. In opening the proceedings the president, Mr. Gerald Stoney, called attention to the report of the Advisory Committee on Industrial Research.

Professor W. A. Bone then presented for discussion the report of the Committee on "Fuel Economy," which we reprint on page 291. He said that the committee did not yet feel in a position to make detailed recommendations on a subject which covered so wide a range, affecting alike the interests of the chemist, the engineer, the geologist and the economist. There was, moreover, little use, for the present, in promulgating even the soundest conclusions, as a great deal of educational work was still to be done to explain to the industrialist and the public in general the importance of the question and the reasons of recommendations made. The committee was appointed a year ago as the result of a discussion in section B on Smoke Abatement. It consisted of 14 members, forming a nucleus to which had since been added others, representative of different industries, so that at present the membership was 45. This large number had not proved unwieldy, since the work had been organised into five sections, dealing respectively with chemical and statistical questions, the carbonisation of coal, metallurgy, and ceramics, the generation of power, and with the domestic uses of fuel. It was early evident that not more than a preliminary survey could be offered in the report to be presented this year. In this they had accordingly decided merely on the lines of investigation to be followed, and they asked for reappointment. It was further felt that the work would be ineffective unless steps were taken to bring the matter before the public at the various industrial centres, and accordingly communication was established with various technical societies at these centres and conferences arranged, of which some six or seven had already been held. Another would shortly meet at Cardiff and others were in prospect. Relations were also established with the coal and coke committee of the Board of Trade, who were, in fact, represented on the British Association Committee. Attempts had been made to draw public attention to the importance of the matter by selected statistics, such as represented by the diagrams, Figs. 1 and 2 of the report. There, was, moreover, an executive committee which met fortnightly in London for the purpose of dealing with any question raised by manufacturers, with whom difficulties were thus discussed in detail. As a result of the work done, the fuel question was now being taken up in such a way that there was every prospect that it would at last result in effective action.

Dr. J. T. Dunn said that the sub-committee which he represented were investigating the nature of coal. Of course many analyses of coal had been made in the past, but these had been concerned mainly with what happened when coal was destroyed in use. Such analyses were of value to the coke maker or gas engineer, who required to know what yields might be expected from particular fuels. In themselves, however, such analyses give no information as to the intimate nature of coal itself. This, however, was a matter of great importance where coal was to be stored, as the liability to spontaneous combustion depended upon the nature of the substances in the coal. Very little definite knowledge as to these was as yet attained. Workers so far had proceeded on one or other of two lines. Either the coal was attacked by reagents and from the nature of the resultant products that of the substances from which they were derived was inferred, or, secondly, the coal was treated by various solvents, thus separating out its various constituents. As stated, little definite knowledge had as yet been acquired. It was known, however, that coal consisted of two or three different constituents. One reason for the slow progress made was that investigators had worked independently of each other. Every worker, however, knew more than he was able to publish, and if he communicated to others the state of his still undeveloped researches, progress would be more rapid. The sub-committee accordingly was intended to form a common pool to which information could be sent even if not ripe for publication. With the work thus co-related each investigator would know what the others were doing and be able to compare not merely matter ripe for publication, but to discuss attempts not yet successful. In this way the speaker thought that progress would be much more rapid than during past years. The work of the sub-committee would therefore be purely scientific in character, and would be costly, requiring considerable financial assistance. Of the statistical work little had been done, though attempts were being made to get reliable data as to mine wastage. Obviously controversy might arise here, as the term economy was capable of different interpretations, and a policy which might be economical from the standpoint of providing a low-priced fuel for use now might not be the best so far as the future interests of the nation were concerned.

Dr. J. E. Stead, who represented the sub-committee dealing with the metallurgical aspect of the question, said that they had endeavoured to ascertain definitely how matters stood and to find out where economy was possible before advising new steps. Circulars had therefore been sent to the firms interested, making inquiries as to present practice. It was recognised that there might be reluctance to reveal private information of this character. Those in advance would not care to tell how this advance had been gained, whilst backward firms would be ashamed to acknowledge the fact. As the speaker was closely connected with certain firms it was felt that he was not exactly the person to receive private data of this character, so that it was arranged that the whole of the replies should be sent to Professor Bone, who alone would have access to the letters. The object of the committee was to obtain reliable data as to the amount of fuel used in the iron and steel industries, and each firm was, moreover, asked in what direction they thought research was necessary. It would be premature to give any forecast as yet, though most of the members knew where economy was required. Next, year, however, they hoped to make definite recommendations.

Mr. H. J. Yates, who followed, dealt with the work of the sub-committee on carbonisation. Before the war he said the gas furnace had attained a fairly high state of efficiency, but much experience had been gained since. In one plant alone the heating furnaces were now consuming 500,000 cubic feet of gas (water gas) per hour and an equal quantity was used in the annealing furnaces. This total was greater than the aggregated hourly make of the gas works of Edinburgh, Leeds and Newcastle combined. The resultant economy was very remarkable. In one case where pure nickel had to be melted the work had previously been done by means of coke. The cost with coke was 4*s.* 2*d.* per 100 lb. of metal melted, the corresponding figure for gas being 1*s.* 9*d.* Taking the labour cost with coke as 100, with gas it was 66, and if the loss of metal with coke was taken as 100, that with gas was 33. Few, he thought, realised the important part gas firing was playing in the production of ammunition of all sizes, from the .303 small bore cartridge up to the 15-in. shells.

Mr. C. H. Merz, speaking for the sub-committee on power plants, said that 100,000,000 tons of coal were required per annum for generating power. What was now required were suggestions as to the practical steps to be taken to secure immediate results.

Sir Hugh Bell recalled that 53 years ago the late Lord Armstrong had discussed the coal position of the United Kingdom. At that date the output of coal amounted to 86,000,000 tons per annum, and 10 years previously it had been 61,000,000. Lord Armstrong assumed that the rate of increase would be 2,500,000 per year, but 10 years after his forecast the figure was 127,000,000 tons, and in 1883 the figure was 163,000,000. Then there was a pause, and the speaker came to the conclusion that no further substantial increase was to be expected. In this he had proved entirely wrong, the figures for 1903 showing an output of 230,000,000 tons of coal per annum, while in 1913 it had risen to 287,000,000. This increase had been made possible only by improved mining methods, which permitted of the winning of coal which it would have been out of the question to mine at the date of Lord Armstrong's speech. Indeed those who looked back would agree that thinner seams were now being worked than would have been thought possible even 20 years ago. Some five or six years ago Sir William Ramsay had made a suggestion for the mining of coal by gasifying it *in situ*. This proposal caused most practical coal miners to smile. At the same time, however, the speaker had felt that a suggestion by Ramsay, who had so often proved the utility of what Tyndall had called the "scientific use of the imagination," was not to be set aside without examination. He had accordingly put at Ramsay's disposal a thin seam of Durham coal, overlaid with clay and containing very little rock. The seam was on the side of a hill and had been partially worked through an adit in years past. Under Ramsay's direction considerable sums of money had been spent, but, unfortunately, Ramsay's long illness and subsequent death put an end to the experiment. The apparatus was, however, still there, and was at the disposal of any one else as imaginative and daring as Ramsay. The experiment was certainly very interesting. Burning coal at the colliery was the ideal, especially of those who, like his friend Mr. Merz, considered that the main purpose of producing energy was to transmit it.

Joking apart, however, a system by which coal in the thinner seams was gasified *in situ* and the products brought to the surface as gas or vapour would add greatly to the prospects of those desirous of transmitting energy from the collieries rather than the solid fuel.

Professor H. Louis said that frank criticism was the best compliment that could be paid to the work of the committee on chemistry and statistics. He would ask them, therefore, were they treating the engineer fairly? The engineer was blamed for wasting the 2 per cent. of nitrogen contained in the coal, but the chemist himself did nothing with the 80 per cent. of cheap nitrogen which existed in the air.

As to the other by-products, why did not the chemist synthesize them from their elements in place of attacking the engineer? In this matter it was necessary to come down to the hard business fact that not a ton of coal was mined for scientific purposes or for any other purpose than the making of money. To obtain the by-products expensive plant was necessary, and with interest charges 50 per cent. higher than they used to be, this was a serious matter. Engineers might well pause, therefore, before investing large sums on recovery plants, in view of the possibility that synthetic chemistry might render the whole useless. In the speaker's opinion, part of the work of the chemical committee should be to do away with the extraction of by-products altogether by finding out how to produce them synthetically. As to the wastage of coal, he had dealt with the matter at a recent meeting of the Society of Chemical Industry. The committee had mentioned faults as occasioning loss of coal, but the waste here was insignificant. What was required was a reduction of the avoidable waste. The Commission of 1905 estimated the yearly waste of fuel in use as between 40,000,000 and 60,000,000 tons. The amount of avoidable waste in the collieries was of much the same order. In fact, by stopping this colliery waste the saving to be effected would be as great as by all other methods of economising fuel put together. There was avoidable waste in the larger barriers left between adjoining properties, but as collieries got bigger this loss was much reduced. In other cases only the best portion of the seam was worked. At Barnsley only the hard coal, amounting to one-third of the whole, was brought to bank, the whole of the soft coal being left below and wasted. In other cases all the small coal was left below, Nottinghamshire and South Wales being particular offenders. In the Nottingham district he had seen coal loaded into the tubs with forks, having tines spaced 1¼ in. apart, and very much the same thing was done in South Wales. The coal left was every bit as good as that raised. If the committee tried to get reliable statistics as to these colliery wastes, they would fail completely unless they had statutory powers. The man who used for colliery purposes but 2 per cent. of the total raised, and left but 1 per cent. waste behind, would fill in all the forms sent. But where 25 per cent. of the coal raised was used by the colliery and 20 per cent. was left below, the forms would simply be put into the waste paper basket. He saw no reason why authoritative figures should not be obtained by Government. The matter was important, as unless definite data were available it would be impossible to say how the waste was to be avoided. The problem was, however, one for the chemist rather than for the engineer. The chemist must show how small coal and the coaly matter in waste could be utilised to advantage. If he did this he would find the managers only too willing to move.

Sir Charles Parsons said that present-day economy in the production of electricity from the burning of coal was not due to engineering progress, but was in the main attributable to the greater size of the units built, which made it possible to introduce means of economy impracticable in the case of small units. The war had made everybody think. He did not agree that there had been too much overlapping of committees. He thought it was well to have several, see how they worked, and let the fittest survive. In this way he thought the stage of ultimate decision would be reached more economically than if special care was taken to avoid the possibility of overlapping. The Advisory Committee on Industrial Research was most anxious to help, and useful work would also be rendered by Lord Balfour's Committee appointed to give effect to the recommendations of the Paris Conference. He had heard reports that if the by-products were extracted from coal, electricity could be obtained for next to nothing, but the chemist had still got to prove this.

Dr. Dugald Clerk said that some time ago he had occasion to go into the question of the coal reserves of the world, and came to the conclusion that at our present rate of consumption industrial civilisation could not last for more than another 5,000 years. In the case of England, however, the reserves would not last more than 500 years. The estimate made in the Census of Production of 1907 was that the aggregate capacity of the engines used in this country was 10,500,000 h.p. The figures for the United States taken for 1909 gave for that country a total of 23,250,000 h.p. In the Census of Production the average fuel consumption per horse-power hour was estimated at 5 lb.; this could be reduced at least to 1½ lb., or to 1 lb. if gas engines were adopted. Our fuel consumption must be reduced or industrial civilisation in England, which commenced only in 1750, could not last more than another 500 years. Cities would in the future be unable to afford the open fires, but would have to go in for a general system of steam heating, using the waste heat from the power stations. By also economising in metallurgical operations and by developing water powers, we should be able to manage with one-half the amount of coal. It was estimated that the total water power available in the world was 200,000,000 h.p., of which only some 13,000,000 had so far been developed. Much had already been done in economising fuel. At the time of James Watt the thermal efficiency of the engine was 4 per cent., whilst a modern gas engine gave now nearly 40 per cent. Much, however, remained to be done, and not only the chemist and engineer, but also the politician must take a hand if the industrial life of this country was to be prolonged beyond 500 years.

Professor Harold Dixon, who spoke next, said that he did not think that there was any prospect, in the immediate future, of persuading the community to give up the open fire. Economy was, however, possible even with open fires if properly constructed and worked. Statistics showed that in the matter of soot and smoke the ordinary domestic fire was a very bad offender. It had been estimated that the domestic use of fuel accounted for one-fifth of the coal mined, and this was burnt in such a way as to produce much more than one-fifth of the total smoke. It was only just to say this, although it would be much more difficult to put a stop to the smoke from the domestic than from the industrial use of coal. He thought that every chemist felt strongly that the present way of using fuel, even if considered merely from the immediate financial standpoint, could not be continued for any long future. The difficulties in the way of reform must be got rid of. It was true that little use was made in this country as yet of nitrogen derived from the air, but he hoped plant for this purpose would soon be at work in more than one town. He had himself seen a fair quantity of nitrogen compounds thus produced here, and at present prices the process was feasible. Nevertheless, the problem of obtaining from coal the nitrogen, toluene, and other by-products, must be faced if this country was to have any great chemical industry.

The next speaker, Dr. Des Voeux, said he represented the Smoke Abatement Society of London, for whom he claimed sole credit for the improvement effected in recent years in the state of the atmosphere in the metropolitan area.

Dr. E. F. Armstrong, who spoke next, said that he was associated with a company which was a very large consumer of coal, the tonnage for the year running into seven figures. This company had studied fuel economy for many years past. Their success had not arisen from an aggregation of units, but by scientific management, which in works of any reasonable size could effect very large savings. The plan indicated was to get hold of the best men possible, give them good salaries, and set them to watch in detail the working of every power plant. His firm had, for example, made many experiments on the value of insulating materials, and by using suitable laggings had saved 1,000 tons of fuel per week. Special attention was given, moreover, to the economisers and stokers, and careful chemical control was kept of the flue gases. In this way enormous savings were effected when comparison was made with the ordinary slap-dash methods followed in many works. The committee should impress on users the importance of the methods he had indicated. The men now being trained by Professor Bone would be specially suited for the work. He agreed with Dr. Clerk that the recent increase in the cost of coal had done more to promote the economical use of coal than anything the committee could expect to do.

Mr. C. E. Stromeyer said that Dr. Des Voeux had told them what he claimed to have done, but the speaker did not accept the view that the whole of the improvement made was due to the action of the Smoke Abatement Society. The Manchester Steam Users' Association had, he might say, paid much attention to the question of smoke prevention, and had conducted many experiments with the object of improving stoking practice. As a result they had strongly advocated the adoption of side firing, but the whole matter had ultimately fizzled out, as factories seemed to care little so long as they got steam. One factor in the production of smoke was that successful manufacturers were often driven into using fewer boilers than they should do. A boiler plant, originally ample, became too small as the works grew, and the boilers were overworked. Only coal of the best quality could then be used, and this was one reason why certain qualities of coal were left behind in the mines, since they could not be sold. The overcrowding of the boiler plant was a chief cause in the production of smoke. If ample boiler power was available there was no reason why smoke should be produced. But with overworked boilers it was necessary to use the very best coal in order to keep steam, and all sorts of devices must also be adopted to keep down the smoke.

Mr. Blackett, speaking as a colliery manager, asserted that for years past consumers had demanded too much coal and at too cheap a rate. He would not adopt the exact text of the proverb about casting pearls before swine, but he would maintain that the collieries had been casting their valuable coals before fools. Far too much was expected from them. Consumers had wasted the fuel just because they could so easily lay hands on it. As no one else would, the collieries had been compelled to use their own rubbish, and to put down coke ovens not with the intention of obtaining the by-products, but simply to get rid of their valuable small coal, as it was easier to sell the coke than to sell this. In past days this small coal had been laid to waste in heaps or used as packing on railways. Now that coke had gone up in price, consumers turned on the collieries and asked why they did not reduce prices by recovering the by-products. If the consumers were prepared to put the collieries back into the old position they would only too gladly sell the coal. Let the prevalent reproaches cease, and let those who made them purchase the coal and do what they liked with it. Of course certain collieries had erected by-product ovens, but in all cases these collieries were closely connected with steel works or the like, and it was accordingly difficult to know the exact position of affairs financially. This could only be discovered where the coal was bought in the open market.

Professor G. G. Henderson said that all chemists felt that the engineer took too one-sided a view of the coal question, seeing in coal but so much fuel, whilst the chemist saw that it was also the source of high explosives, synthetic drugs, and the like, and did not wish to see all these thrown away by the coal being regarded as a source of energy only. On the other hand, the open fire could not be abolished altogether, but by the use of smokeless fuel it could be prevented from actively contributing to the formation of a London "particular." He hoped that in the future—indeed, in the immediate future—we should find in the low-temperature distillation of coal a solution of the smoke problem.

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CONSTRUCTED BY THE NILES-BEMENT-POND COMPANY, ENGINEERS, NEW YORK.

(*For Description, see Page* 276.)

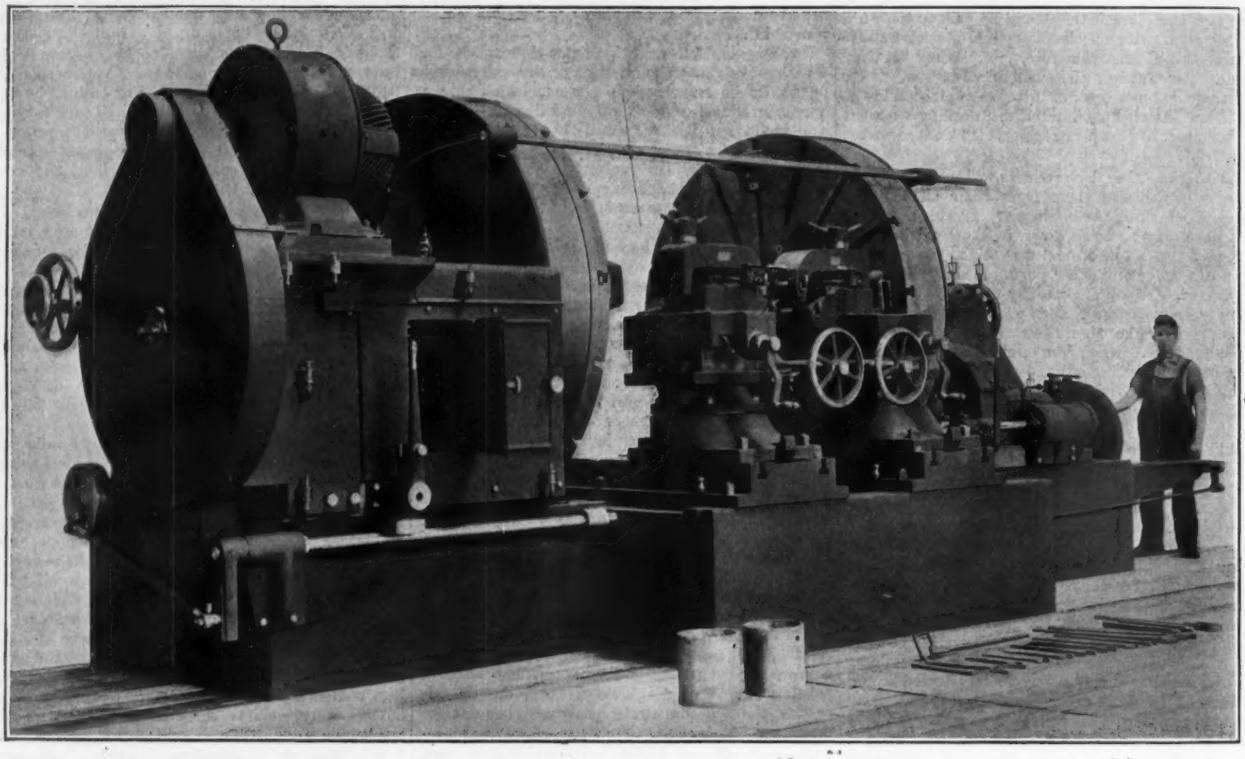


FIG. 1.

Professor Bone, in responding, said that any assistance Professor Louis could give in improving the estimates of colliery waste would be welcomed. He was glad to have had Dr. Armstrong's statement showing what could be done in the matter of fuel saving by establishing scientific supervision. He knew personally something of what had been achieved at the factory to which Dr. Armstrong had referred, and he had long held that every large fuel consumer should retain a special fuel chemist with nothing else to do than to look after this one matter. He had known of several cases in which the engagement of competent men of this kind, at good salaries—and they could not and should not be got on other terms—had saved the salary ten times over.

In bringing the morning's proceedings to a close, Mr. Gerald Stoney observed that the greatest economy in fuel would be achieved by the discovery of other sources of power, and he was not sure that this was impossible. The sun and tide no doubt were useless as sources for practical reasons, but Clerk Maxwell had pointed out that power in almost unlimited quantity existed in the molecular motion of the surrounding air. To utilise it, however, it was necessary to get over the second law of thermodynamics, which someone had explained as the principle owing to which it was impossible to boil a kettle by seating it on a block of ice. To utilise the energy latent in the air, Maxwell's "Demon" must be discovered, and the speaker lived in hopes that some day he would be found, in which case we should be able to dispense with collieries and effectively economise our coal.

ELECTRIC POWER DISTRIBUTION.

At the afternoon meeting on the 8th inst., in introducing his paper on "Electric Power Distribution" (published on page 262 *ante*), Mr. C. H. Merz stated that the importation of the Parsons 20,000–25,000 k.w. steam turbine into Chicago had led to an improvement of 20 per cent. in the economy of the steam turbines constructed by American builders.

FUEL ECONOMY.

Mr. R. P. Sloan next read a paper on "Fuel Economy on the North-East Coast as a Result of Electric Power Supply." We reprint this on page 293. The discussion on the two papers was taken together. It was opened by Mr. B. W. Woodhouse, who said that whilst all seemed to agree on the necessity for economy in the use of fuel, each section seemed to think that it was the other section which should undertake the work. The greatest stimulus to economy of fuel was an increase in the price of coal. This had risen steadily for 20 years past, and was still going on, but was as yet far from effective in compelling economy. There had been a serious lack of co-operation between the producer of coal, the user of coal, and the producer of power. The most direct method of bringing about the changes in practice required would be to place a tax on the use of raw coal, the proceeds to be applied to promoting economy in fuel. Such a tax would advance matters rapidly. Funds would obviously be wanted for the objects in view, and he suggested that the adoption of his proposal would provide them and in the fairest way. Those who were economical in coal would pay proportionately the least, and refunds might be made in cases where the coal was treated to the best advantage. As matters stood, out of an annual output of 270,000,000 tons of coal, but 30,000,000 were carbonised, so that 240,000,000 tons were consumed without extraction of their by-products. A tax of a penny a ton on this would yield a million sterling, and the rate might be progressively raised till it reached 1s. a ton. Such a tax would give a valuable stimulus to the objects the meeting had in mind. One effect of the increase in the cost of the coal and in its carriage was to make the low grades less valuable, so that it became more and more necessary to consume these in the actual coalfields. Carbonisation should therefore go hand in hand with the production of power. What had been done in the north-eastern counties could be done in other areas by the co-operation of owners and users of coal with power-generating companies. In the case of the Yorkshire Power Company, with which the speaker was connected, there were in the area of supply 400 collieries, producing 30,000,000 tons of coal per annum. Co-operation with the power company here would lead to a great increase in the carbonisation of coal, the utilisation of low-grade fuel, and a reduction of power costs. The coal now burned at the collieries for different purposes would, if used by a power company, provide not merely the power required by the collieries, but for all the textile factories in Yorkshire, and there were many of these. A commencement had been made. A portion of the power generated was obtained from coke-oven gas, and by the end of the year the power plant would be in active co-operation with works engaged in low-temperature carbonisation. These works would supply power gas to the power company, and sell the coke for use as domestic fuel. The speaker hoped that in spite of previous disappointments this scheme would be successful. The works were situated in the actual coal district, and given a market for the smokeless fuel produced, and for the oils recovered, the project should be successful. The market for metallurgical coke was definite and limited, and there was no use in producing more of it. Taking the country as a whole, not more than one-tenth of the power used in industries was obtained from public electric supplies. The use of machinery here was, moreover, capable of being greatly extended. Census figures showed that in the United States the power consumption per workman employed was three times as great as here. In any event, whether this use of power were multiplied by 10 or by 30 in the future, it was obvious that electric power production must

90-IN. LATHE FOR LOCOMOTIVE DRIVING-WHEELS.

CONSTRUCTED BY THE NILES-BEMENT-POND COMPANY, ENGINEERS, NEW YORK.

(*For Description, see Page 276.*)

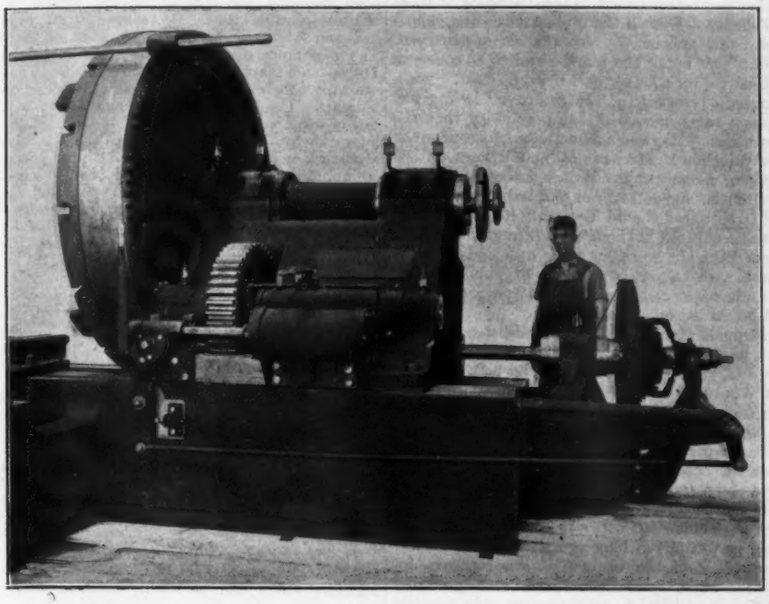


FIG. 2.

increase enormously, and he hoped that the power companies would now go ahead rapidly. This had not been the case in the past for a variety of reasons. Municipal plants existed in all the areas. In Yorkshire, out of a total population of 3,000,000, 2,000,000 were concentrated in the larger towns. Power companies were not allowed to supply in these towns save by consent of the municipalities. Where these were themselves prepared to supply cheap power, they might perhaps be allowed to object, but in many cases they furnished either no supply at all or only at very high rates. It had taken a long time to persuade the public that these restrictions were not in the interests of the country as a whole. Even to-day there were 12 municipal plants in his area not connected with each other or (one excepted) with a power company. There seemed to be a better prospect of co-operation now, which would not only lead to cheap power supplies, but would get rid of the smoke so harmful both to health and to agriculture.

Mr. Mclaurin, of Glasgow, said he had been particularly struck with the paper by Mr. Merz, in which the author—though an engineer—had not neglected the chemical aspect of the problem. Professor Louis had blamed the chemist for emphasising the value of by-products and for expecting the engineer to deal with these before the financial soundness of the proposal had been proved. The chemist had, however, done his part in showing that these by-products could be obtained, and it was now quite as much an engineer's question as the chemist's. The speaker was only a chemist, and regarded the matter from the chemist's standpoint. Professor Louis had sneered at the 2 per cent. of nitrogen in coal, but even this figure was high, the average nitrogen content being more nearly 1.4 per cent. This fraction was, however, not to be lightly dismissed. If it could all be obtained and turned into ammonia, the value of 2 per cent. of nitrogen in the coal would be 16*s.* per ton, or 12*s.* if the nitrogen content was taken as 1.4 per cent. So far it had not proved feasible to recover the whole of the nitrogen from the coal, and probably it never would be. Nevertheless a yield of 90 to 100 lb. of sulphate of ammonia could be obtained which, after deducting labour and chemical charges, would at 1*d.* a lb. be worth 8*s.* per ton of coal. Moreover, the amount of oil to be recovered also offered a fair picture. Ordinary coal yielded 15 to 25 gallons of oil per ton, and some cannel coal as much as 30 to 40 gallons per ton. The whole of this was recoverable. He had been asked by a colliery company if he could handle a cannel coal containing 30 to 40 per cent. of ash. From an analysis, he had assumed that this coal should yield 35 gallons of oil, and works were established accordingly. The colliery had previously been burning 100 tons of this coal per week for boiler firing, as it was unmarketable, because it could not be burned with an ordinary chimney draught. Since, however, it had been put through a producer the weekly coal consumption at the colliery had never been more than 80 tons, and from each ton 40 gallons of oil and 40 lb. of sulphate of ammonia were recovered. It was found, moreover, that two boilers, fired with the producer gas, would do the work for which three had previously been necessary. On behalf of the Glasgow Corporation he had for the last year or so been experimenting with a plant intended to supply illuminating gas and smokeless fuel. So far as the latter was concerned success had been obtained. The results showed that 66 per cent. to 75 per cent. of the original energy of the fuel could be returned for boiler firing, whilst the oil extracted represented 10 to 15 per cent. of the energy in the raw coal, so that the loss inside the apparatus averaged somewhere about 20 per cent. In other words, taking the raw coal, they produced a fuel containing 70 per cent. of the energy of this coal and recovered 15 to 20 gallons of oil and 40 to 60 lb. of sulphate of ammonia, and he believed that a return of 90 to 100 lb. would be possible. The ammonia recovered at 1*d.* a lb. was worth 5*s.*, and the oil at 3*d.* a gallon was worth another 5*s.*, making a total return of 10*s.* in exchange for the 30 per cent. of energy retained from the fuel. These yields had been actually realised, but it was not yet certain that 3*d.* per gallon could be obtained for the oil. The coal was distilled by internal in place of by external heating, in a producer 30 ft. high by 8 ft. in diameter. It was a simple producer, in which the hot gases going up through the fuel took up with them the oil, which was subsequently trapped. This oil was entirely different from any he had had previous experience of, resembling rather a crude oil from an oil retort. It dried rapidly on either wood or glass, acting in some ways like linseed oil. He would be glad of assistance in investigating its properties, as the problem continued to get deeper and deeper. From this crude oil it was possible to obtain 6 per cent. of a light oil distilling at a temperature of under 170 deg. F. There was no benzol and no toluene. By treatment with acid the oil could be separated into two distinct portions. One appeared suitable for use as a lubricant, and 8*d.* per gallon had been offered for it if its flash point could be raised. Six per cent. of cresylic acid was also obtained. The heavier portion separated was suitable straight away for use as a varnish if dissolved in benzol, and were the latter available the varnish would be worth 1*s.* to 1*s.* 4*d.* per gallon. A peculiarity of the tar collected was that it was wholly soluble in sodium hydrate, and from this the speaker concluded that it might represent a resin forming an original constituent of the coal. The producer temperature was so low that such a resin might well be able to get through it. The capital cost of the plant was only one-quarter of that usual, being 1,500*l.* for a plant capable of dealing with one ton of coal per hour.

Mr. Chamen, who followed, observed that the Board of Trade had issued a circular calling attention to the necessity of linking up power stations, and as a consequence representatives of the municipal engineers and of the power companies had met in conference, and appointed a committee to deal with the matter. Several meetings had been held, and the point had almost been reached for the taking of practical steps in the matter. The conclusion arrived at was, that whilst co-operation was possible in the matter of generating electricity, there should be no interference with existing systems of distribution. The scheme adopted provides for the division of the country up into areas, and in each area a committee was to be formed to consider the whole question for themselves. To a large extent the linking up of generating stations was possible under existing powers, so that it would not be necessary to go to Parliament at all. The sooner the controversy between municipal and company enterprise could be got rid of, the sooner would it be possible to realise the economies outlined in Mr. Merz's paper. In certain cases linking up was already in operation, and with a considerable saving in working costs. The arrangement made was that each party should partially shut down on alternate weeks, the one station carrying the whole of the normal load of both, and the other acting merely as stand-by to take the peaks. In this way it was possible to arrange that no money passed between the two undertakers, and something worth having was saved in labour and by the fact that many boilers could be closed down and the remainder worked at full load. He hoped a good deal more would be heard of such arrangements. In one regard legislation might prove necessary, since if the linking up movement progressed, the main trunks referred to by Mr. Merz would be required. As matters stood, the supply authorities had power to make agreements with landlords, but had no statutory powers to acquire wayleaves, the landlords having, therefore, an absolute veto. Most of them were reasonable, but occasionally one was met with who was not. For this reason the Post Office had found it necessary to secure an Act giving them the necessary powers to deal with such cases. What was possible for the Post Office should also be possible for the electric power supply authorities. He mentioned this matter now since, if it was necessary to go to Parliament, the promoters would need all the assistance they could get.

Mr. A. H. Barker said that apparently the greatest economy in the use of coal would be obtained by gasifying it and recovering the by-products. It was perfectly possible to run gas-fired boilers, and to do so more economically than with raw coal. It was also evident, however, that much more work had to be done than when raw coal was used in the furnaces. Large areas were necessary for the plant, which must include very expensive works for distilling the coal and recovering the by-products, since if this was done at all it must be done on an enormous scale. Each by-product represented, in fact, a business in itself, requiring a large staff. The electric industry could not undertake such work in addition to that of supplying energy. Hence

he thought the handling of the by-products should be undertaken by an independent company concerned in this matter solely, but working, of course, in close touch with the power station. There should be no difficulty in keeping the two undertakings distinct, both financially and in actual working. He would suggest that an association should be formed for handling the coal of the country on these lines. It might consist of coal-owners and users of by-products, and should have statutory powers, with a limitation of possible profits. It had been pointed out that the most economical way of transmitting energy was to do so electrically, but the speaker thought that one might go further, since electricity could be used for every purpose for which coal was now employed, inclusive of domestic needs as well as of power supply and furnace heating. Large stations could supply current at a very low figure, which was, moreover, being reduced year by year. If the whole of our coal was thus transformed into electric energy we should need stations fifty times as large as at present, and with these the cost of power would be far below present prices. With such stations energy could be supplied for all manufacturing and domestic uses at less cost than these were now provided for by coal. Mr. Woodhouse had referred to low-temperature carbonisation as yielding a smokeless fuel. This fuel could be used for any processes for which electricity was not suitable. With regard to the installation of such giant stations, it had been suggested that they should be close to the large coal areas, but it was also necessary to have an ample supply of condensing water. The Midlands were badly off in this regard, cooling towers being necessary. In the Birmingham district alone these towers evaporated about 1,000,000 gallons per day, whilst the whole water supply of Birmingham, which was brought from Wales, was only 25,000,000 gallons daily. Hence for a station fifty times the size of the existing stations the supply of water available was insufficient, and it might be necessary to locate the stations at places where ample water supplies were available and to rely on trunk mains to convey the electric current into the industrial areas where it was required. The cost of such transmission could be reduced to a very low figure, as there was no objection to the adoption, for transmission purposes, of a voltage of 100,000. It was, however, difficult to see how the provision of such enormous stations could be arranged for within a reasonable time. If the natural development of the demand were relied on, progress would be too slow to meet the necessity of economising fuel now. This aim would be attained more quickly by compelling all users to take their supplies of energy in the electrical form. This could be done either by appropriate taxation or by Parliament forbidding the use of other methods. Full justification for such a course was to be found in the necessity of properly conserving coal supplies, of eliminating smoke, and of providing power at so low a price as to effect a substantial saving in the production costs of our manufactures. Moreover, if the handling of the coal were concentrated into certain areas the railways would be greatly relieved, and general traffic be benefited. Such coal transport as might be necessary could be conducted over special lines.

Mr. Highfield said that two problems had to be considered, viz., the better use of coal for producing energy, and, secondly, the better use of coal, having regard to the recovery of by-products. These two problems were, it was true, inter-related, but they were essentially separate problems. From both aspects, however, it was evidently necessary to operate on a very large scale. So far as distributors of electricity were concerned, much had already been done in linking up stations and in operating on a larger scale. He did not like the idea of appealing to Parliament in the matter. The earlier legislation on electrical matters was of the faultiest description. The Act of 1882 only allowed electrical undertakings a life of 21 years and this Act stopped progress in this country for six years. This was done in spite of the fact that the bulk of the inventions involved were due to English engineers, and the result was that we allowed other countries to get a clear start of six years. He was therefore fearful of more legislation, and hoped there would be no more unless promoted by the electric industry itself. He looked on both the questions he had raised as purely economic in character. If it paid to burn coal carefully this would be done, but if fuel could be got very cheaply, or if the plant for its economical use involved much trouble or expense, little would be done. The question had better be left to the discretion of users of all classes. Even if there were only enough coal to last us for another 500 years it was necessary to find out how much the plant required to conserve our resources for a longer period would cost. Were we to keep reserves for the future by laying out enormous sums now, with the possibility that the discovery of "Maxwell's demon" might render the whole valueless? He was not himself keen on the sinking of money unless proper interest could be earned on it, and it had not yet been proved that these large sums should be spent in coal saving. If it was profitable, he thought users might be trusted to undertake the work for their own ends, but he did not wish to see large sums of public money sunk unless it was quite clear that proper interest could be earned on the outlay.

Dr. Dugald Clerk said that he had listened to Mr. Merz's paper with mixed emotions. If the latter succeeded, gas engine builders would be wiped out, and the only thing left for the speaker to do would be to design the internal combustion turbine and beat Newcastle. The coal gas industry, moreover, would disappear if Mr. Merz's scheme obtained immediate success. However, this country had always been great on compromise, and had a native distrust of a too rigid logic. Experience had shown that this suspicion was commonly justified. Buckle had observed long ago that the distinctive characteristic of the German was a fondness for deductive logic, whilst the Englishman preferred induction, and liked to wait and see. In practice it often chanced that something that in strict logic could not happen actually did, hence whilst the strictly logical method proved profitable sometimes, at others it came to grief, and in such cases the Englishman found himself in a very favourable position. Hence, although as a Scotchman he should prefer deductive methods, experience had led him to the conclusion that the human mind was too limited to make too deliberately prepared plans, and he thought therefore that the gas engine and steam turbine would for long exist together. A thermodynamic efficiency of 16 per cent. was considered good when the gas engine was first introduced. Now efficiencies near to those obtained with gas engines were being recorded for steam, and the gas engine builder would accordingly have to see whether he could not raise his efficiencies to, say, 60 per cent.

Professor Bone, in bringing the discussion to a conclusion, and with it the proceedings of Section G, said that if the report of the committee had done nothing else than give rise to this discussion it would have been amply justified, and he invited those who had further remarks to make to present them in writing, as the committee were particularly anxious for further memoranda and data. Interviews could be arranged with the authors of such communications when desired. They were most anxious to make their labours fruitful in the coming year, and be able to present at the next meeting something in the nature of a final report.

(To be continued.)

BUILDING MATERIALS IN NORWAY.—The prices for all building materials have risen to such an extent, bricks, for instance, about 100 per cent., lime 50 per cent., and cement about 33 per cent., that the fixing of maximum prices is being urgently advocated.

MANUFACTURE OF HARDENED STEEL GEARS.—The production of hardened steel gears as nearly perfect in shape as is possible in gear-cutting and boring machines, and doing this without subjecting the otherwise finished and hardened gears to a final grinding operation are, says *The Iron Age*, the claims made for an invention on which a patent (U.S. 1,152,157) has been granted to Frank H. Farmer, Cleveland, Ohio, and assigned to the White Company of that city. The method consists in rough machining the gear blanks and then carbonising them. The carbonised gears are heated up, quenched in oil, and then annealed. The annealed gears are machine-finished and finally oil-hardened. This treatment, it is claimed, does not warp or destroy the accurately-shaped machine-finished products.

90-IN. HEAVY WHEEL LATHE.

WE illustrate in Figs. 1 and 2, on pages 274 and 275, a 90-in. driving wheel heavy lathe built, at their works at Hamilton, Ontario, U.S.A., by the Niles-Bement-Pond Company, of New York, and of 25, Victoria-street, London, S.W. This machine has been designed for turning driving wheels in the shortest possible time. It swings 90 in. over the bed and will take wheels up to 86 in. on the tread. The maximum distance between the face-plates is 110 in. and the minimum distance 80 in. The lathe can take wheels or axles having either inside or outside journals. The headstocks are mounted on a heavy bed of deep box section, thoroughly stiffened at short intervals by box section cross-girts. The left-hand headstock is bolted rigidly to the bed and carries the 50-h.p. electric driving motor; this headstock is of the enclosed type and contains the driving and change-speed gearing, doors at the front providing ready access for inspecting the mechanism. The right-hand headstock is illustrated separately in the view, Fig. 2; it is movable, and is adjusted to a sliding fit on the bed. This headstock is provided with power traverse operated by a separate 8-h.p. electric motor which, to save floor space, is placed within the bed, where it is easy of access. The motor is engaged by means of a large friction clutch operated by a lever so located that the operator can traverse the headstock without leaving his working position near the wheels. The friction clutch is adjusted so as to slip when excessive power is applied, thus eliminating any risk of damage should the face-plate be brought up too forcibly against the wheels. A quick-acting powerful device enables the operator to instantly clamp the right-hand headstock by simply turning an air valve; the device is operated by a large air cylinder and clamps the headstock to the bed at both the front and back simultaneously.

The face-plates are mounted on extra large steel spindles; the main spindles are provided with heavy bushings which can be readily replaced when worn without disturbing the alignment of the bearings. When wheels with outside journals are to be turned, the centres can be run back into the spindles by means of a hand-wheel. The face-plates are provided with T-slots and each is equipped with four "sure grip" drivers engaged by hand and exerting a uniform pressure on the wheel. The face-plates are recessed to receive the crank pins, thus enabling the wheels to be chucked close to the face-plates with the resulting increased rigidity of drive. The face-plates are driven by internal gears; the pinions are of forged steel and are mounted on auxiliary shafts, as shown in Fig. 2, an arrangement which increases the ratio of the driving shaft to the face-plate, with a resulting decrease in the torsional strains on the driving shaft. The driving pinions, which are located at the front of the machine about on a line with the tools, tend to counteract the cutting strains and relieve the pressure on the main spindle bearings.

The tool rests have sufficient in-and-out adjustment on the bed to turn wheels from 40 in. diameter on the tread up to the capacity of the machine. The tool slides have in-and-out adjustment for setting the depth of cut, also longitudinal traverse by large hand-wheel and longitudinal power feed. The feed screws have ball-thrust bearings and the slide bases have bronze plates on their upper surfaces where the tool slides bear. The tool rests are equipped with the company's patented pneumatic clamps, which enable the operator to change and clamp the tools in a few seconds and without the use of a wrench. The feed is positive in action, the range being from $\frac{1}{12}$ to $\frac{1}{18}$ in. per revolution of the face-plate. There are nine feeding strokes per revolution, so that the feed is practically continuous. All gears are enclosed or covered by suitable guards.

POLISH-ENGLISH AND ENGLISH-POLISH DICTIONARY.—We have received from Mr. Leopold B. Hill, 2, Langham-place, W., a copy of Hill's Polish-English and English-Polish vest-pocket dictionary, which measures 5¼ by 2½ in., covers 382 pages, and is issued at the low price of 1*s*. This dictionary, the thirteenth of an excellent series, is carefully prepared and clearly printed.

SOCIETE NATIONALE DE CHIRURGIE DE PARIS.—A donor who wishes to remain anonymous has offered to this Society a prize of 50,000 francs (2,000*l*.) to be handed over to the maker of the mechanical apparatus which best supplies the place of the hand. All competitors must belong to allied or neutral nations. They are to present to the Society mutilated men who have been using their apparatus for at least six months. The Society will experiment with each apparatus on mutilated men for the length of time it thinks fit. The apparatus gaining the reward is to remain the property of its inventor. The competition will be closed two years after the end of the war. MM. Faure, Kirmisson, Quenu, Rieffel and Rochard, who make up the committee elected by the Society, ask any person wishing to compete to send his memoir and apparatus to M. le Secrétaire Général de la Société Nationale de Chirurgie, 12, Rue de Seine, Paris.

INDUSTRIAL NOTES.

THE Director of the Department of Labour Statistics, writing in the *Board of Trade Labour Gazette*, says that all the principal industries continued to be fully employed in August, and an increasing shortage of labour was experienced, especially in those directly engaged upon Government contracts. As compared with a year ago, employment was better in all trades, except in a few adversely affected by war conditions.

The changes reported as taking effect in August affected about 320,000 workpeople, and resulted in a net increase of nearly 45,000*l.* per week. The principal bodies of workpeople affected were coal miners in Durham, skilled classes employed in shipyards in the North-East Coast, Clyde, East of Scotland, Hull, Barrow and Birkenhead districts, engineers in the Clyde, North-East Coast and Birmingham districts, and iron puddlers and millmen in the Midlands.

The total number of disputes beginning in August was 26, and the total number of workpeople involved in all disputes in progress was 21,096, as compared with 34,520 in the previous month, and 28,870 in August, 1915. The estimated total aggregate duration of all disputes during the month was 78,900 working days, as compared with 118,000 in July, 1916, and 109,600 in August, 1915.

The average weekly number of vacancies notified to all Labour Exchanges for the four weeks ended August 11 was 39,113, as compared with 39,154 in the previous five weeks, and with 31,984 in the four weeks ended August 13, 1915. The average weekly number of vacancies filled for the same periods was 30,846, 30,823 and 24,373 respectively.

The general level of retail food prices in the United Kingdom on September 1 was 4 per cent. above that of August 1. As compared with September 1, 1915, retail food prices on the 1st inst. showed an average increase of 22 per cent. Taking the country as a whole, and making allowance for the relative importance of the various articles in working-class household expenditure, the average increase in the retail prices of food since the beginning of the war may be put at 65 per cent.

In Berlin the general level in July, 1916, stood at 117.6 per cent. above that of July, 1914. In Vienna the general level in July last was about 161 per cent. over that of July, 1914. In Switzerland the figures for June, 1916, show a rise of 40.6 per cent. as compared with June, 1914. In Italy the rise in June last is 33.3 per cent. over the level of July, 1914. In Norway, and between the same dates, the rise has been about 61 per cent., whilst at Copenhagen the food bill has risen by about 46 per cent.

In an interesting letter to the editor reproduced in *The Times* of the 11th inst., Mr. Edmund Kimber states that after the war the public debts of all Europe and the British Empire are likely to be at least 25,000,000,000*l.* Even the neutral countries are likely to be involved to the extent of at least 500,000,000*l.* The payment of these debts has an intimate connection with the employment of labour. The Allies will probably have to meet at least 15,000,000,000*l.*, and get what they can out of Germany, Austria and Turkey. But it is to great public remunerative works we must look if we wish to be solvent. Mr. Kimber then states that by a proper distillation of coal, so as to save all the by-products, this country could not only save 100,000,000*l.* per annum, but the sulphate of ammonia produced would, if properly applied, double the production of the land and give employment to at least a million people. The utilisation of sewage in a more efficient manner and the planting of waste places with trees would in time bring in about 10,000,000*l.* per annum and give employment to about 100,000. Five thousand miles more of railway could be constructed in India very profitably, giving occupation to hundreds of thousands here and many millions there. In Africa the Cape to Cairo Railway is not yet finished. The French Government before the war was contemplating the construction of a railway from Bizerta across the Sahara, the French and the Belgian Congo. Railways and canals could be made profitably in Australia and Canada. Many rivers in South Africa could be canalised. The Nile right away to Khartum could be made more navigable if five more of its cataracts were harnessed. Great harbour works in this country and in Canada are very much wanted. The Channel Tunnel, adds Mr. Kimber, is now a work of absolute necessity, and if set about at once after the war would relieve some of the want of employment and be the cause of many industries afterwards.

In the course of his presidential address to the Institution of Mining Engineers held in Glasgow on Thursday, the 14th inst., Mr. Wallace Thorneycroft stated that minerals were the primary raw materials necessary to create the plant and machinery required for the manufacture and transport of all the necessaries of life derived from agriculture used in the form of food and clothing, and also for the conveniences we enjoyed. Consequently the cost of production of our minerals very materially affected the cost of living at home, and was a much greater factor than was generally recognised in the maintenance of our export trade in finished articles by means of which we paid for the food we required to import.

In order to bring out the effect of increased cost of coal on other industries, Mr. Thorneycroft gave an example of the increase in cost of the coal used to manufacture one ton of acid steel plates made in Scotland from imported ores, comparing the year 1904 and the spring of 1914. The difference was an increase of 14*s.* 6*d.* per ton of steel plates. This included all the fuel used in converting the iron in the ore to steel in the plate. Of this a little more than 4*s.* 6*d.* represented the amount due to higher rates of wages and one or two other items, so that the increase of cost of the fuel in 1914 above 1904, with miners' wages at the same rate and other things about equal, would work out at just about 10*s.* per ton of steel plate. This represented the cost of legislation, as specially affecting the coal trade in Lanarkshire, passed between 1904 and 1914, and which had to be paid by the steel-plate industry. Mr. Thorneycroft, after referring to the questions of scientific training and the elaboration of improved processes of manufacture, said that he did not dispute that both employers and employed in this country had got to improve their practice in order to maintain or improve upon the standard of living of, say, the year 1911, but he emphatically protested against the notion that in order to do this they must imitate German methods. Provided we had in the future reasonably wise legislation and freedom from internal strife, industrial or otherwise, he had no fear that we should not be able to hold our own and more in industrial affairs.

In the monthly report for September issued by the United Society of Boiler Makers and Iron and Steel Shipbuilders, the General Secretary states that the attitude of the Admiralty "in continuing to class our riveters and caulkers employed on construction and repair of warships as 'skilled labourers' is wholly indefensible, since we have admitted them to full recognition in our ranks. These members of ours are in every respect equal to our members employed in private shipyards, and ought to be classed and paid as craftsmen. The war will hold our hands from taking any action that will in any way delay work in our Royal Dockyards, but should we again fail to obtain satisfaction by constitutional means, then the Admiralty cannot blame our riveters and caulkers, after the war is over, if they seek elsewhere their rights which the Admiralty has so long denied them."

The society has a total membership of 74,274, all classes of members included. The balance in hand at June 30 was 431,960*l.*; the balance on December 31, 1915, was 400,277*l.*, showing an increase of 31,683*l.* for the half-year.

The monthly report, dated the 8th inst., issued by the Steam Engine Makers' Society states that at the close of 1915 the capital of the society stood at 171,000*l.*; at the end of the half-year ended May, 1916, the figure was 184,000*l.*, whilst at the present time it is at least 190,000*l.*, equal to 9*l.* per member.

Sir George Hayter Chubb has stated that when he was in charge of the London works of his company, about 40 years ago, he introduced piecework and fixed the prices to be paid to the workmen on the basis of the previous 10 years' average wages earned. The immediate result of this measure was that the men obtained from 15 to 20 per cent. more money, and the output of the works increased 10 per cent.

Since our note on page 250 *ante* of our last issue, meetings of the Executive of the National Union of Railwaymen and of the Associated Society of Locomotive Engineers and Firemen have been held; the President of the Board of Trade has also had interviews with these Executives and with the general managers of the railway companies, with reference to the increase in wages demanded by the men. An agreement has been come to. The previous war bonus of 5*s.* for employees of 18 years and upwards is to be increased to 10*s.*, and an extra 2*s.* 6*d.* is to be given to those whose previous bonus was 2*s.* 6*d.*—employees under 18 years of age, with some exceptions.

In pursuance of a decision of the War Committee, the following have been appointed to serve as a "Man-Power Distribution Board":—Mr. Chamberlain, chairman; Viscount Midleton, vice-chairman; Mr. Arthur Balfour, J.P. of Sheffield; the Right Hon. G. N. Barnes, M.P.; Mr. Stephen Walsh, M.P. Mr. E. A. Sandford Fawcett, M.I.C.E., has been appointed secretary to the Board. The duty of the Board will be:—"To determine all questions arising between Government Departments relating to the allocation or economic utilisation of man-power for the purpose of the successful prosecution of the war and, in order to give effect to its determination, to direct the Government Departments concerned to create the machinery necessary to co-ordinate their activities in regard to the distribution or utilisation of men and women. The Board will not consider individual cases which will be dealt with as heretofore by the machinery already provided, and will act only on representations from Government Departments." All communications should be addressed to the Secretary, Man-Power Distribution Board, India Office, Whitehall, S.W.

COLONIAL AND FOREIGN ENGINEERING PROJECTS.

WE give below a few data on some colonial and foreign engineering projects taken from the *Board of Trade Journal*. Further information on these projects can be obtained from the Commercial Intelligence Branch, Board of Trade, 73, Basinghall-street, E.C.

Australia.—The Melbourne Office of H.M. Trade Commissioner in Australia states that sealed tenders, on the proper forms, will be received, up to noon on November 2, by the Chairman of the Electric Supply Committee, Town Hall, Melbourne, for the supply, delivery and erection of an electrically-operated coal transporter plant capable of handling 80 tons per hour.

Republic of Colombia.—The *Diario Oficial*, Bogota, contains a law authorising the Colombian Government to contract a loan or loans to the sum of 400,000 pesos gold (about 80,000*l.*) for the extension of the Tolima Railway to the town of Ibagué.

ON THE USE OF A SUBSTITUTE FOR PETROL.—The Committee of the Commercial Motor Users' Association held an emergency meeting to discuss the matter of supporting an appeal by the Llandudno Motor and Garage Company, Limited, concerning the conviction of that company and its employees by the Conway Magistrates for using a substitute for petrol in their motor *chars-à-bancs*. It was decided to support the appeal, which will constitute a test case for the whole country. The decision will be awaited by all owners owing to their inability to obtain a definition of "motor spirit" from any Government Department. Counsel for the appeal will be Mr. Ellis Griffiths, K.C., M.P., and Mr. W. Caradoc Rees, M.P.

"A THOUSAND-AND-ONE USES FOR GAS."—In view of the recommendations contained in the report of the special Home Office Committee on Factory Lighting, which will undoubtedly become law when more immediately urgent affairs have been satisfactorily carried through, factory owners and works managers will be interested in a monthly illustrated serial dealing with this subject, published by the British Commercial Gas Association, 47, Victoria-street, Westminster. The current issue discusses in detail various points in this report and gives facts and figures, substantiated by photographs of existing installations, to show how economically and efficiently the Home Office's requirements as to illumination in factories can be fulfilled by means of incandescent gas.

CANADIAN RAILWAY ADMINISTRATION.—The gross revenue of the Canadian Pacific Railway Company for 1915–16 was 129,481,886 dols., of which working expenses absorbed 80,255,965 dols. The ratio of the working expenses to the traffic receipts for the year was 61.98 per cent., leaving the net earnings at 38.02 per cent. In 1914–15 the working expenses were 66.04 per cent., and the net earnings 33.96 per cent. During the past year 390,715 acres of agricultural land were sold for 6,126,108 dols., giving an average of 15.68 dols. per acre. Included in this were 8,046 acres of irrigated land, which brought 54.67 dols. per acre, so that the average price of the balance was 14.86 dols. per acre. The Canadian Pacific Ocean Services, Limited, is virtually part of the Canadian Pacific undertaking. The revenue returned from steamships is exclusive of an amount transferred to the reserve fund to cover the cost of replacing ships sold or destroyed. The appropriation made for expenditure on capital account in 1915–16 was 3,749,474 dols.; of this sum 955,000 dols. was required for the Connaught Tunnel in the Selkirk mountains, and the balance was for miscellaneous improvements extending over the whole system. The actual expenditure made on capital account upon the Connaught Tunnel in 1915–16 was 1,251,732 dols. The expenditure on capital account upon the company's property at the close of June, 1916, was 530,788,979 dols., viz., railway, 352,971,898 dols.; rolling-stock, 153,605,368 dols.; and ocean, lake and river steamers, 24,211,713 dols. Some 3,000,000 acres of coal rights have been reserved from lands sold and unsold in Alberta; these lands are to be developed upon a royalty basis. Rights have also been reserved in 100,000 acres of natural gas lands sold and unsold in Alberta. Petroleum rights have been further reserved in 50,000 acres of lands sold and unsold in Alberta, and to be developed upon a royalty basis. Last year's working expenses included 14,671,791 dols. for maintenance of way and works, and 16,695,956 dols. for maintenance of rolling-stock.

1500-KW. GEARED TURBO-GENERATOR; CONDENSING PLANT.

CONSTRUCTED BY THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, MANCHESTER.

Fig 23

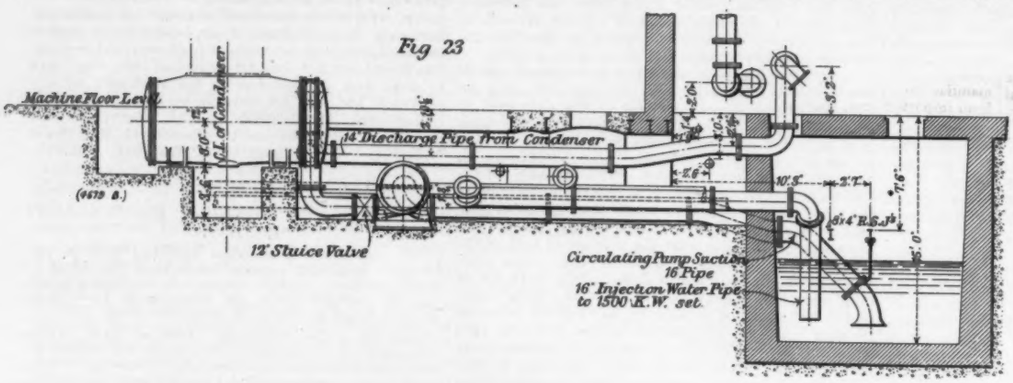

Machine Floor Level
C.L. of Condenser
14" Discharge Pipe from Condenser
(4679 B.)
12" Sluice Valve
Circulating Pump Suction 16" Pipe
16" Injection Water Pipe to 1500 K.W. set.

Fig. 26. DETAIL OF STAYS

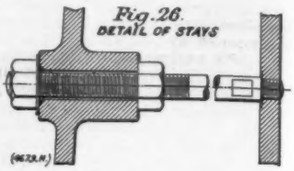


Fig. 27.

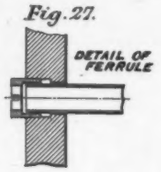


Fig. 24.

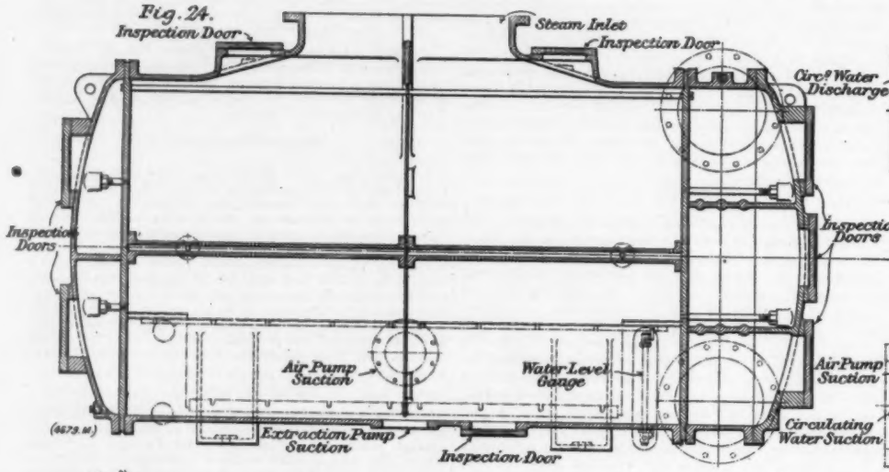
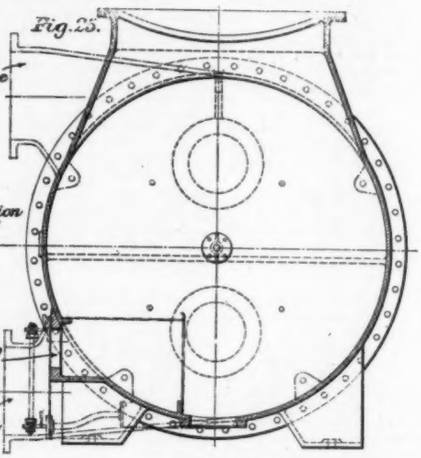


Fig. 25.



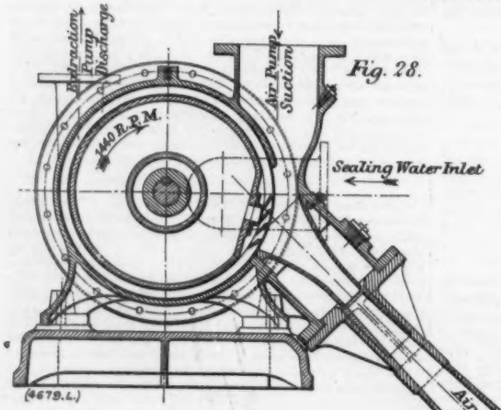
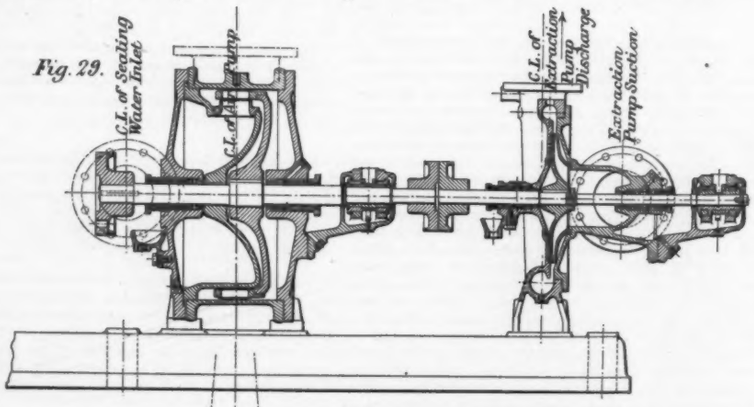


Fig. 28.

Fig. 29.



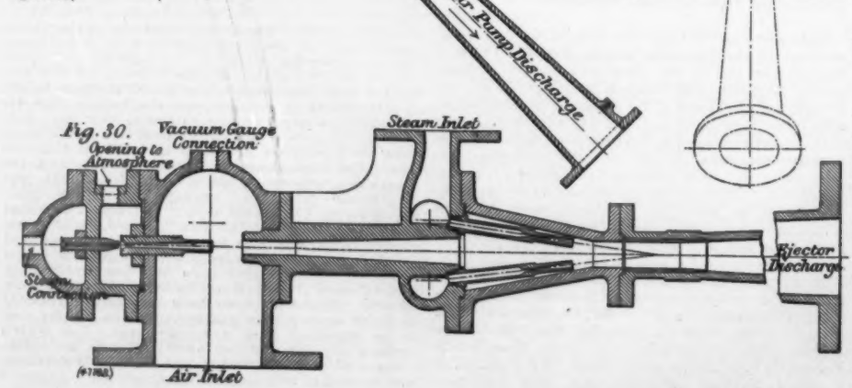


Fig. 30.

1500-KW. GEARED TURBO-GENERATOR AT THE WESTINGHOUSE WORKS, TRAFFORD PARK, MANCHESTER.

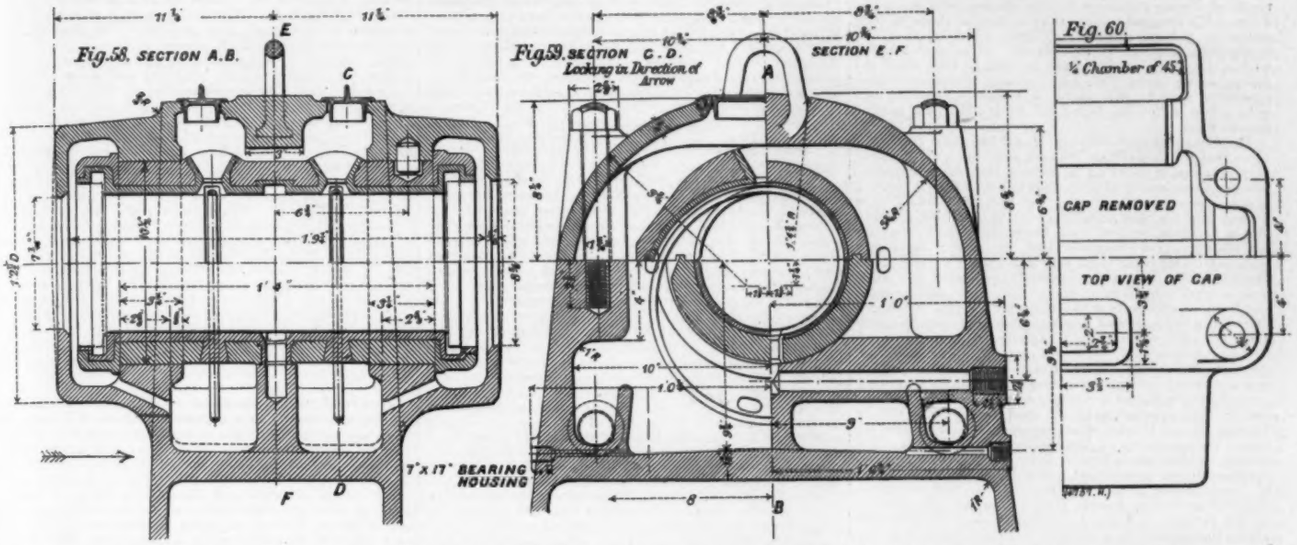
(*Concluded from page 223.*)

As previously indicated, the condensing plant comprises a number of new departures. The surface condenser, which is shown in Figs. 23 to 27, on the present page, is of the firm's standard four-pass type, having 2,244 tubes, with a total surface of 4,300 sq. ft. An enlarged detail of the water-box stays is shown in Fig. 26 and of the tube gland in Fig. 27. The circulating water is obtained from the Ship Canal, being led to the power-station by a concrete conduit, shown in Fig. 23. It is pumped through the condenser by a motor-driven centrifugal pump.

The main air pump is of the Leblanc type, whilst a second centrifugal pump mounted on the same shaft, as indicated in Fig. 29, withdraws the condensate. The power necessary is supplied by an electric motor. Sections of the Leblanc pump are given in

1500-KW. GEARED TURBO-GENERATOR; DETAILS OF BEARINGS.

CONSTRUCTED BY THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, MANCHESTER.



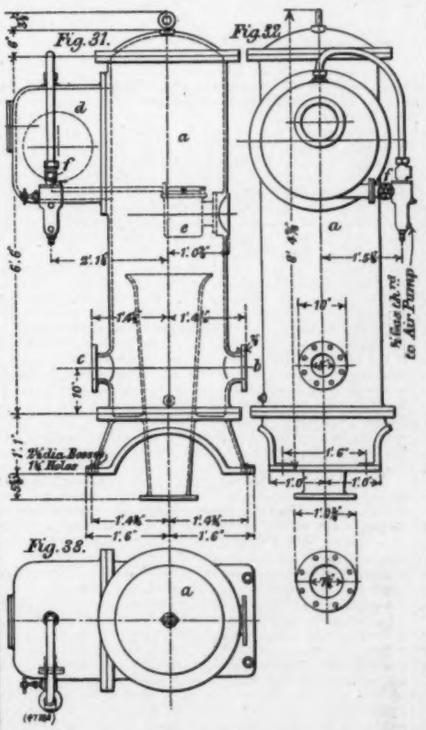
Figs. 28 and 29. This pump was described in detail in our issue of May 7, 1909, page 626, and we need only recall here that plugs of water delivered from the rapidly revolving impeller entrap between them layers of air, which are carried with the escaping water to a tank, from which the entrained gases escape into the atmosphere. In principle the action is comparable to that of the Sprengel pump, the high momentum of the plugs of water compensating for their low specific weight.

An important addition to this pump is the new type of "seal" tank, which is illustrated in Figs. 31 to 33. It has hitherto been usual when water ejectors, either of the fixed or rotary type, are used as air pumps, for the discharge to be made into an open tank, from which also the pump takes its supply of water. The quantity of water passing into the pump depends upon the difference between the pressure at the tank and that at the pump suction. Hence, if a serious air leakage arises, increasing the pressure at the pump suction, less water will enter the pump, whilst, if anything, the conditions require an increase of this quantity. To obviate this the Westinghouse Company have adopted the form of seal tank shown in Figs. 31 to 33 annexed. This is a closed tank communicating with the outer air only by an outlet the area through which is varied automatically as the quantity of air to be extracted changes. The pump discharges into this tank, as shown in the general arrangement in Fig. 1, on page 220 *ante*, and the gases liberated collect in the upper portion, whence they escape into the atmosphere. If but little air is being extracted, the pressure in the seal tank is practically atmospheric; but if the quantity of air increases, the pressure in the tank rises, thus providing the greater head required for maintaining the proper flow into the pump.

The apparatus consists of a casting fitted at the bottom of the bell-mouth pipe through which the discharge from the air pump enters. The supply to the pump leaves through the branch *b*, whilst the branch *c* supplies any "make-up" which may be required. Annexed to the upper part of the tank is a float chamber *d*, which controls the valve shown by the dotted lines at *e*. This valve maintains constant the level of water inside the tank. The adjustable orifice through which the air escapes is shown at *f*. The adjustment is effected by a spring-loaded plunger, subject on the one side to the pressure at the pump inlet, and at the other to the pressure at the top of the tank. The adjustment is such that the difference of these two pressures is maintained constant, and the feed of water to the pump becomes accordingly independent of the amount of air leakage.

The water-extracting pump, as our engraving, Fig. 29, shows, has but a single stage. A somewhat higher efficiency could have been obtained by compounding this pump, but the saving in power would be more than offset by the additional cost and complication.

In addition to the Leblanc air pump, the condenser is also provided as a stand-by with a steam-jet air pump of a novel type. A section through this arrangement is illustrated in Fig. 30, on the opposite page. A peculiar feature of this extractor is that a mixed jet of steam and air is employed. The steam jet is shown at the left of Fig. 30, this jet discharging into a a chamber which is in communication with the outer air. The air expands from atmospheric pressure down to the pressure existing in the condenser, partly separately from the steam and partly after mixture with the latter. A mixed jet of the two passes through a second nozzle, sucks the air from the condenser and discharges it into a third nozzle. This discharges into



a chamber, in which a partial vacuum is maintained by the additional steam jets shown. These further compress the air and deliver it to the outer atmosphere. This extractor works equally well at light and at full loads. The steam consumption is about 2½ to 3 per cent. of the main turbine consumption. This is a very reasonable figure for an emergency air pump of such simple construction and containing no moving parts. The steam used for the jets can, moreover, be discharged directly into the hot-well and its heat contents recovered.

The construction of the generator is illustrated in Figs. 34 to 57, Plate XXV, and Figs. 58 to 60, above. It is rated at 1,875 k.v.a. at 0.8 power factor, generating three-phase current at 440 volts with a periodicity of 25 cycles per second. The machine is, as will be seen from Fig. 34, completely enclosed and is self-ventilating, two fans being mounted as indicated on the rotor shaft at *h h*. To prevent air entering at the points where the shaft passes through the casing, guard-rings are fitted, as shown at *i i*. Details of these rings are given in Figs. 47 and 48, whilst Figs. 45 and 46 show typical cross-sections of the rotor shaft. The stator is constructed on the same lines as in the case of direct-connected turbine-driven generators, and is accordingly very robust. The insulation, so far as is practicable, is of mica throughout. An elevation and plan of the stator casing are represented in Figs. 39 and 40, whilst Fig. 35 shows the arrangement of the end conductors. A winding diagram is reproduced in Fig. 42. The end windings are very rigidly braced, so as to avoid displacement in the case of a short-circuit. A typical stator stamping is represented in Fig. 43, an enlarged view of the keyway in it being given in Fig. 44. A cross-section through the windings is reproduced in Fig. 36, and shows how the connector-bars are secured. Particulars of these bars are reproduced in Fig. 38. One of the main conductors can be seen in place in Fig. 36. There are 84 of these bars to the complete stator, having the dimensions given in Fig. 37. Particulars of the slots will be found in Fig. 49.

The rotor body and shaft are one solid forging, the pole tips being bolted on, as best seen in Figs. 50 and 51. Details of these pole-pieces are reproduced in Figs. 55 to 57, whilst Fig. 54 shows a half end elevation of the rotor at the poles.

The construction of the field winding is of interest, as it consists of two concentric coils separated from one another by an air space, best seen in Fig. 50 and in the diagram, Fig. 53. Through this space a ventilation current flows when the machine is at work. Between turns the insulation is of asbestos, and the insulation to ground is also, so far as possible, of a fire-proof character. The bearings for the shaft are ring-oiled, and are illustrated in detail in Figs. 58 to 60, on the present page.

IMPERIAL INSTITUTE.—A series of popular lectures on "The Tropical Countries of the Empire," illustrated by the collections of the Imperial Institute, will be delivered by Miss Edith A. Browne, F.R.G.S., on Wednesdays in October, November and December, at the Imperial Institute, at 3 o'clock, commencing on Wednesday, October 4, 1916. Admission to the series of lectures will be free by ticket, for which application should be made to the Director of the Imperial Institute, South Kensington.

THE POLYTECHNIC SCHOOL OF ENGINEERING.—The Polytechnic, 307 to 311, Regent-street, W., notifies that courses of instruction are to be given in its rooms during the forthcoming session. The session will commence on Monday, October 2, but the heads and teachers of the various departments will be in attendance each evening during the week beginning September 25, for the purpose of advising intending students in the selection of a course which will be of the greatest help to them in their daily occupations.

ENGINEERS AND THE JUTLAND BATTLE.

THERE was published in *The London Gazette* of Friday last a "Supplement" to the despatch of Sir John Jellicoe, drawing the attention of the Lords of the Admiralty to the gallant and distinguished services rendered during the battle by the officers and men of the Fleet. We are glad to note that in this list there is, very properly, a large number of officers and men of the engineering branch of the Navy. It is not possible within the limits of the space to deal as fully with the matter as we could wish, and we must therefore confine ourselves more to the results in respect to awards and promotions following from Sir John Jellicoe's recommendations.

The Conspicuous Gallantry Medal has been conferred upon Stoker Petty Officer William Ackerman, for aptitude and bravery in clearing a suction box in a damaged compartment and freeing the rods in use to keep it clear, it being necessary at one time for him to descend in a diving suit for the purpose; also upon Chief Engine-Room Artificer, Second Class, Frederick Tinsley Birchall, for showing great coolness and resource in removing portions of shafting from forward to enable the after-steering position to be successfully operated; this work was carried out under a heavy fire. The same medal has been conferred on Petty Officer Frederick Adolphus Day (alias Parsons) and Leading Seaman James Simpson Watson, who, when a shell exploded in the starboard battery of their ship, causing a quantity of smouldering debris to fall among a hoist of cartridges in bags, showed great coolness and presence of mind, Day in immediately jumping amongst the cartridges and removing the debris, and Watson in assisting him; upon Stoker Petty Officer Patrick James Hogan, who remained for over eighteen hours continuously at his station, where, during the action, the fans were broken down and the temperature became almost unbearable, while in order to stop leaks in cover joints he had to take off his clothes; upon First Class Stoker Joseph Henry Hughes, who, as one of the ratings on duty in a compartment immediately above that struck by a torpedo, whereby the deck of the compartment was distorted, all lights save one extinguished, and water entering, at once closed a valve, and, the last light going out, proceeded on deck to obtain another with which he returned, closing steam and exhaust valves, although there was then five feet of water in the compartment; upon Chief Stoker William George Pring, who, although severely wounded early in the action, continued to carry out important duties with repair parties until the action was finished; and upon Acting Stoker Petty Officer Frederick John Henry Wherry, who at great risk flooded the 6-in. magazine of the ship in which he was serving, and then, until gassed, assisted to extinguish a fire in close proximity to the magazine, and subsequently, while still suffering from the effect of the fumes, left the dressing station to unlock the secondary position for 13.5-in. flooding valves.

There is a long list of recipients of the Distinguished Service Medal. These include 16 chief engine-room artificers, 6 engine-room artificers, 3 mechanicians, 2 leading stokers, 11 chief stokers, and 22 stokers. The following have also been commended for good services in action on the occasion referred to: 14 chief engine-room artificers, 10 engine-room artificers, 5 mechanicians, 5 leading stokers, 15 chief stokers, and 21 stokers.

Regarding the honours conferred, we note with pleasure that Sir John Jellicoe has been appointed to the Order of Merit. Sir David Beatty has been made G.C.B., and Rear-Admiral Hugh Evans-Thomas and Rear-Admiral W. C. Pakenham, K.C.B.'s. The list of C.B.'s includes Engineer Captain John Richardson and Engineer Captain Arthur Frederick Kingsnorth.

The promotions and appointments to the Most Distinguished Order of St. Michael and St. George include, to the class of Knights Grand Cross, Admiral Sir Cecil Burney; to be K.C.M.G., Vice-Admiral Thomas Henry Martyn Jerram, Vice-Admiral Sir Frederick Charles Doveton Sturdee, Bt., and Vice-Admiral Sir Charles Edward Madden. Distinguished Service Orders have been conferred upon Engineer Commanders, William Cory Sanders, Robert Spence, Reginald William Skelton, and Henry Walton Kitching, and Engineer Lieutenant-Commanders Harold Bertram Tostevin, John Kirk Corsar, and Albert Arthur Green Martell, while the Distinguished Service Cross has been bestowed upon Chief Artificer Alexander Noble and Artificer Engineer Joseph House.

A large number of recommendations for promotions have been made, and in many cases the recommendations have already been given effect to. These include Engineer Commander William Toop to be Engineer Captain, Engineer Lieutenant-Commander Arthur Lee Picton to be Engineer Commander, Engineer Lieutenant-Commander Bertram Harvey to be Engineer Commander, Engineer Lieutenant Godfrey Morgan to be Engineer Lieutenant-Commander, and Chief Artificer Engineer James Henry Fenton to be Engineer Lieutenant. The following officers have been noted for early promotion:—Engineer Commanders Herbert Brooks Moorshead, Charles Frederick Dunn, and John Downie Wilson; Engineer Lieutenant-Commanders Arthur Ellis Lester, Harold Edwin Brook, Harold Benjamin Main, Albert Knothe, and Engineer Lieutenant William David Smith; Artificer Engineers Joseph Fegan, William Perry Hill, Frederick Samuel Heath, Gilbert Mager McWhirter, Thomas John Gard, and Charles Keeling; also Acting Artificer Engineer Francis William John Patterson. In accordance with the foregoing, Engineer Lieutenant-Commander A. E. Lester has been promoted to the rank of Engineer Commander in H.M. Fleet. Engineer Commander John Benjamin Hewitt is among the list of those whose services have been specially noted.

The President of the French Republic has bestowed the decoration of the Legion of Honour, with the approval of His Majesty the King, on various officers, including the *Grand Croix* to Admiral Sir John B. Jellicoe, the *Grand Officier* to Admiral Sir Cecil Burney, Vice-Admiral Sir David Beatty, and Vice-Admiral Sir Reginald Hugh Spencer Bacon. Among other decorations we note the *Croix de Chevalier* to Engineer Commanders Geo. Fredk. Thompson, Francis John Sutton and John Benjamin Hewitt; and to Engineer Lieutenant-Commanders John Edward Greig Cunningham and William Edmund Carter. The *Medaille Militaire* has been bestowed upon the following:—chief artificer engineers, 3; artificer engineers, 5; chief engine-room artificers, 6; chief petty officer mechanic, 1; engine-room artificers, 3; chief stokers, 1; stokers, 2.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, September 6.

Many inquiries for shell steel are floating around, finding very little encouragement because of over-crowded conditions at mills. Deliveries are asked for during the first half of 1917. European demand for ship-plates is active and large orders are being placed. Domestic shipbuilding plants are springing into existence and established yards are expanding. Plate-making capacity is rapidly enlarging. Domestic structural demand has suddenly assumed large proportions. Nearly every steel order is for next year's delivery. Buying of a railroad equipment for domestic and foreign requirements has taken on fresh life. The continued heavy European demand for mill products has forced American buyers into the market to make more liberal provision for next year. As a result of this a sudden and sweeping demand for pig-iron has sprung up at northern and southern furnaces. A number of furnaces are already sold up to July 1. All hopes of a break in prices have disappeared, the momentum of the present buying movement will largely absorb the production of the latter half of next year. By that time quite a number of new furnaces will be in blast. Two 10,000-ton rail orders have just been placed. Buyers of steel are insisting on prompt deliveries according to specifications. The entire industry is straining to the limit. The coming of cooler weather will increase output. Tin-plate capacity is unequal to demand. Sheet mills are declining some business. Coke production is catching up to demand. The Morgan agency is inquiring for 50,000 tons of angles for use in the French war zone. The industry is endeavouring to prepare for continued pressure for products throughout next year, and with additional capacity and a relative diminution of war demands some easing up in prices is naturally regarded as among reasonable probabilities.

THE PRICE OF TUNGSTEN.—The Ministry of Munitions makes the following announcement:—"The price of ferro-Tungsten is officially fixed at 5*s.* 6*d.* per lb. of Tungsten content, and Tungsten powder at 6*s.* 3*d.* per lb., based on ore at 60*s.* per unit. The price of the product is on a sliding scale which rises or falls 1*d.* per lb. with each variation of 1*s.* per unit of the ore."

THE LONDON SCHOOL OF ECONOMICS.—The following lectures, among others, have been arranged for the ensuing session. Transport: General Economics, with special reference to Transport, a course of ten lectures by Mr. W Tetley Stephenson, B.A., St. Catherine College, Cambridge, lately on the staff of the North-Eastern Railway, and now lecturer on Railway Organisation at the City and Guilds College, on Mondays, at 6.15 p.m., in Michaelmas Term, beginning October 9. Fee, 1*l.* 1*s.* Railway Rates and Fares, a course of ten lectures by Mr. Stephenson, on Wednesdays, at 6.15 p.m., in Lent Term, beginning January 17. Fee, 1*l.* 1*s.* Railway Economics—Commercial, a course of 20 lectures by Mr. Stephenson, on Thursdays, at 6.15 p.m., in Michaelmas and Lent Terms, beginning M.T. October 5, L.T. January 18. Fee, 2*l.* 2*s.* Special Problems of Railway Operating caused by the War, a course of ten lectures by Mr. Stephenson, on Mondays, at 6.15 p.m., in Lent Term, beginning January 15. Fee, 1*l.* 1*s.* Canals, a course of lectures will be given during the session by Sir W. H. Lindley. Application should be made to the Secretary at Clare Market, Kingsway, London.

TOWN GAS FOR MOTOR CARS.—Mr. Richard Liggett, secretary of the Foremen's Association, Corporation Gas Department, Glasgow, read a paper on "Town Gas for Motor Cars" before a meeting of the Association on the 15th inst. In his paper Mr. Liggett described experiments which he had made in driving a motor car engine with town gas; he removed the ordinary petrol jet from the carburettor and inserted the grill injector by means of a plate screwed to the flange seat of the petrol jet, and then used the throttle in the ordinary way. The success attained was such as to lead him to endeavour to make a proper control. This he did by a new controller, which was tried on several types of engines, including a 25 h.p. Halley and a 16 h.p. Albion. One of the engines was driven at considerably over 1,000 r.p.m., and was also reduced to a speed as low as that given by petrol by the movement of the usual throttle lever on the steering wheel. The car was also driven backwards and forwards in a space of 12 ft., with brakes applied, the movement of the car being allowed for by the use of 12 ft. of flexible tube attached to the ordinary gas pipe. Afterwards Mr. Liggett worked out a plan for storing gas, and as a result of further experiments he found that the consumption of gas on a run of 15 minutes was 40 cub. ft., working out at 160 cub. ft. per hour, and costing less than 4¼*d.* Ultimately he came to the conclusion that, while the fact that a great power can be carried in a very small tank is a strong point in favour of petrol, gas should prove a very serious competitor for short distance runs or town work.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—Owing to a variety of causes, several pits are not working at full pressure. Many more men are wanted at certain collieries. The present output of all classes of fuel is being readily absorbed from day to day and numerous customers are not able to secure all they require. The demand for manufacturing coal of all classes is heavy. There are ample supplies of best steams for contracts, but no surpluses for other business. Cobbles and nuts are also well held, and slacks give signs of recovering their strong position following upon the complete resumption of work in the cotton districts. A large quantity of gas-making fuel is going away under contract to inland works, whilst there is also a good tonnage for export. Householders are seeking full supplies of all qualities of their special brands. Blast-furnace coke continues strong at top prices. The general export position shows a falling off. France and Italy are the largest customers, for neutrals are not getting very heavy supplies. Swedish steelmakers have been pressing for shipments of South Yorkshire hards with varying success. Quotations:—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best silkstone, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire best brights, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire house, 16*s.* to 17*s.*; best large nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; small nuts, 15*s.* to 16*s.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; smalls, 8*s.* to 9*s.*

Iron and Steel.—Sheffield steel manufacturers are finding themselves so completely hidebound by regulations and restrictions that there is a very present danger of production being very much restricted by the very measures by which the authorities hope to facilitate it. The new regulations for the control of all kinds of steel other than crucible are the latest case in point. Rolling mills are unable to accept orders which are not accompanied by the necessary permits and references, and much work is held up in consequence. There are numerous cases where the work is really marked "A" in the munitions classification, but owing to the delay in the issuing of permits by the Ministry the orders are given before the documents arrive. The mills, however, cannot execute the work as they were able to do before the new restrictions came into force, and it is calculated that the vast amount of production which is being held up is causing grave hindrance to the trade generally. The regulations affect all branches of industry and all quantities and qualities of material. Even the additional clerical work necessary is a burden, though this is slight when compared with the general effect upon output. So keen is the feeling on the matter that local manufacturers have formed deputations to await upon the Ministry of Munitions and state the injurious effect the regulations exercise. In the material market there is no marked change to record. Common irons remain firm at the current prices of 90*s.* for both Lincolnshire and Derbyshire forge and 92*s.* 6*d.* for the foundry brand. Heavy buying of hematite continues, and mixed numbers are better to obtain. Bars are now priced at 13*l.* 15*s.* to 14*l.*, with delivery at works, and sheets 20*l.* to 21*l.* Trade with Russia is being conducted at a high figure in anticipation of the approaching closing by ice of the port of Archangel. Recent shipments included high-speed and carbon steel, files of all sizes, saws, and engineers' tools of every description. The general overseas trade is maintained at a good figure. Tools are in big demand from South Africa, Australia and elsewhere, cutlery for all the colonies, and steel and steel goods for all foreign and colonial business houses. New departures are constantly being made in all the large works. Several important schemes of extension, which cannot be given in specific detail, are in hand. Manufacturers do not hesitate to scrap plant whenever more serviceable machinery becomes available. Proof of this is abundantly produced in the growing popularity of electric furnaces, especially for the output of high-speed steel.

Sheffield Trade Matters.—Messrs. John Brown and Co., Limited, of Sheffield and Clydebank, issued their annual report to the shareholders on the 16th inst. A profit on the year's working of 553,072*l.* has been made, compared with 586,243*l.* last year. The dividend proposed, of 12½ per cent., is the same as in 1915. Of the balance, 150,000*l.* is to be placed to reserve and 147,795*l.* carried forward. The directors observe that all departments have worked at full pressure. Wages advances and high prices of raw materials have increased the cost of production.

GERMANY'S SURPLUS STOCKS.—We read in *The Textile Mercury* that Mr. H. G. Seltzer, United States Consul at Breslau, who is at present in the United States, announced at a recent meeting of the Philadelphia hosiery manufacturers that dye-stuffs were one of the three commodities which he believed were held in surplus in Germany. The others were sulphuric acid and Portland cement.

THE HÉRCULT ELECTRIC STEEL FURNACE.—We read in *The Iron Age* that the United States Steel Corporation has granted licences for the installation of four more Hércult electric steel furnaces, there being a 2-ton furnace to the Warren Steel Casting Company, St. Louis, and three 6-ton furnaces to the Alabama Power Company, Anniston. These four furnaces bring the number of Hércult furnaces in operation or contracted for in the United States and Canada to 76. On January 1, 1916, the number was 43, so that the rate of increase this year has been more rapid than ever before.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The pig-iron warrant market still remains in a condition of lifeless inactivity, the stocks in store in Glasgow being much on the level of a week ago.

Sulphate of Ammonia.—At a meeting of the directors of the Scottish Chamber of Agriculture held in the North British Station Hotel on Thursday last, attention was drawn to the fact that, notwithstanding the arrangement which had been announced by the Board of Agriculture with reference to the price of sulphate of ammonia, purchasers have had the greatest difficulty in procuring adequate supplies from the manufacturers. This has given rise to some considerable dissatisfaction as the rate which was fixed—15*l.* per ton, with the option of buying smaller quantities—was to hold good until the end of September.

Scotch Steel Trade.—In the West of Scotland generally the sectional holidays are now a thing of the past, and in all directions work is once again in full swing, with the steel works more actively engaged than ever, for without doubt the offensive movements of the past few days must have made severe inroads upon the stores of munitions and other war material. No matter what turn affairs take there is every evidence that the approaching winter will witness a condition of activity hitherto unequalled in the Clyde area. Still, naturally, the requirements of the naval and military authorities are of first importance, and these are leaving little opportunity for the carrying out of mercantile orders for private consumers. At the same time, even without this branch of trade, the orders on hand would keep the large staffs employed for many months to come. Manufacturers of steel and steel plant are looking well to the future as evidenced by the number of extensions which are being carried through, and in the event of a sudden cessation of hostilities all the necessary change in this direction would be but immaterial—the only difference would be some slight changes in quality and sections and sizes to be rolled. Prices remain as quoted last week, with export rates leaning towards a rise.

Malleable Iron Trade.—The makers of malleable iron are again finding difficulty in undertaking all the orders which are forced upon them in consequence of the heavy handicap in connection with the supplies of raw material. Not only is there the known scarcity but the question of delivery is a very serious problem. While the steel departments are overwhelmingly busy with contracts for the Allied Governments, the difficulty of obtaining full supplies of raw material is causing some considerable amount of this work to be executed in iron. As things are licences are practically unobtainable. Prices are firm, and "crown" bars are now quoted 14*l.* 5*s.* per ton net, f.o.b., although higher rates are not unknown.

Scotch Pig-Iron.—Business still goes briskly in the Scotch pig-ron trade, there being no slackening off in the Government demands. Everything possible is being done to safeguard a sufficient supply for war purposes, as, through a continued scarcity of several brands of foundry iron, there is an additional run on hematite for the requirements of the Allies. The entire output of hematite is quickly being disposed of locally, and it is doubtful, even with the improved means of production, if the demand is being fully met. Practically no export business is being put through. All over, prices keep firm, although unchanged.

SCIENCE AND DYES.—It is interesting to learn that special attention to the science of dyes is engaging attention in Australia. At the meeting of the Royal Society in Melbourne, Mr. E. J. Hartung showed a series of synthetic dyes and pointed out the relationship between chemical constitution, fluorescence and colour exhibited by certain of the dyes. It was shown that the more common dyes showed either a quinone, azo, nitro or sulpho-grouping, and that by changing one constituent of the dye without altering its grouping a whole series of different colours could be produced. Mr. Hartung also showed a new dye discovered in the chemical laboratory of Melbourne University but not yet fully investigated.

EMULSIFIED OR "CUT" PETROLEUM.—Many of the oil wells in the Cushing pool of Oklahoma yield an emulsified or "cut" petroleum, which pipe-line companies refuse to accept because it contains sediment that will not separate well on standing, and because the oil is said to spoil the stills in the refineries. Examining such oil, Mr. C. K. Francis, of the Oklahoma Agricultural and Mechanical College (*Journal of Industrial and Engineering Chemistry*, August, 1916), finds that ten minutes' treatment in the centrifuge separated about 1.6 per cent. of a residue from the oil, the residue being mainly water. By filtering and washing he isolated 0.505 per cent. of insoluble residue, about half of which was non-volatile mineral matter, the other half being organic and volatile. The mineral matter consisted of 75 per cent. of common salt, 13 of gypsum, 7.6 of calcium chloride, 2.7 of sand, and nearly 1 per cent. of magnesium chloride. The chlorides, especially the $MgCl_2$, are very objectionable, as they may damage the stills and condenser coils by generating hydrochloric acid when heated in the presence of water. There are patented processes to get rid of the water and salt solution. A. T. Beasley applies a strong electrostatic field to the oil; the small drops or bubbles formed then unite to a chain stretching over from one electrode to the other, and when the potential is sufficiently high the oil skin of the bubbles are supposed to break and the droplets unite to a big drop, which sinks.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—The general situation may be described as a trifle easier. The Control Committee continue to allocate supplies of Cleveland pig in such a way as to meet all legitimate home needs and leave a surplus for delivery to our Allies, but there seems little or no likelihood of licences being forthcoming for shipment to neutrals, and merchants with commitments to neutral countries are now cancelling their contracts. The result is that a little prompt iron is coming on the market and it readily finds buyers at above normal rates. The extension to the end of October of permission to sell for delivery to Scotland has brought in quite a large number of orders for customers North of the Tweed. Agitation of Scottish buyers for further extension of time of delivery has not been successful, and it is apparent that buying for Scotland is only to be permitted from month to month to meet actual needs. Supply of forge iron is now fairly plentiful, and there are sellers prepared to dispose of this quality at a little below recognised market quotations. For home consumption No. 3 Cleveland pig is 87*s.* 6*d.*, and that price also rules for No. 4 foundry and No. 4 forge, whilst No. 1 is put at 91*s.* 6*d.* So far as foreign trade is concerned France is the principal customer, and consumers in that country are buying No. 3 direct from makers at 95*s.*, though the general export quotation is fully 97*s.* 6*d.* As a matter of fact above the latter figure has been paid for warrant iron. No. 1 is quoted 102*s.* 6*d.*; No. 4 foundry, 96*s.* 6*d.*; and No. 4 forge, 95*s.* 6*d.* for shipment abroad.

Hematite Iron.—As regards hematite iron, new business is almost impracticable, there being practically no stocks and the production to the end of the year sold. Allocation is very strictly supervised. Only odd small transactions are occurring, but deliveries on running contracts, are well maintained. Nos. 1, 2 and 3 East Coast brands remain at 122*s.* 6*d.* for home use and for shipment to France, and 140*s.* and upward for general export.

Output of Pig-Iron.—All that now is needed to increase the production of pig iron by the blowing in of additional furnaces is the readjustment of labour and it is hoped that this will be satisfactorily arranged in the near future. There is now a plentiful supply of coke, and several idle furnaces are quite ready for relighting. The number of furnaces at present in operation on the North-East Coast is 70.

Coke.—The rather heavy local requirements are met by a much more than ample supply of coke, and quotations, though not quotably lowered, are easier. Average blast-furnace kinds are 28*s.* at the furnaces, and up to 30*s.* 6*d.* at the furnaces is still asked for qualities low in phosphorus.

Foreign Ore.—Imports of foreign ore continue heavy. So far this month unloadings at the port of Middlesbrough are officially returned at no less than 135,473 tons.

Manufactured Iron and Steel.—No new features of moment are ascertainable concerning the various branches of the finished iron and steel industries. Numerous ordinary commercial inquiries are reported, but they attract little attention, as manufacturers continue very busily employed on Government work. Common iron bars are 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; iron ship plates, 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 17*l.* 10*s.* to 18*l.* 10*s.*; packing iron and steel (parallel), 11*l.*; packing iron and steel (tapered), 13*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.*; steel joists, 11*l.* 2*s.* 6*d.*; steel hoops, 16*l.* 10*s.*; steel strip, 17*l.*; heavy sections of steel rails, 10*l.* 17*s.* 6*d.*; and steel railway sleepers, 12*l.*

Shipments of Iron and Steel.—Shipments of pig-iron from the Tees so far this month amount to 23,769 tons, as compared with 32,502 tons to the same date last month, and 14,436 tons for the corresponding part of September last year. Clearances of manufactured iron to date this month are officially returned at 1,475 tons, and loadings of steel at 1,060 tons.

NOTES FROM THE SOUTH-WEST.

Cardiff.—Steam coal has continued as scarce as ever and there is no immediate indication of supplies available for general export increasing, the authorities monopolising the production of superior qualities, including Monmouthshires and seconds. Business for prompt shipment has been impeded by the facts that only odd parcels could be picked up here and there and that exporters have been obliged to keep steamers waiting for long periods. Forward business has also been checked by delays in the completion of the scheme for the limitation of prices for Italy and other Mediterranean countries. House coal has been scarce and firm. All classes of bituminous coal, patent fuel, and coke have made full prices. The best Admiralty large steam coal has been, to some extent, nominal; secondary qualities have made 43*s.* to 45*s.*; Monmouthshire Black Veins, 44*s.* 6*d.* to 45*s.*; ordinary Western Valleys, 44*s.* to 44*s.* 6*d.*; Eastern Valleys, 40*s.* to 43*s.*; best bunker smalls, 30*s.* to 33*s.*; and cargo smalls, 20*s.* to 25*s.* per ton. In bituminous coal No. 3 Rhondda large has been making 42*s.* to 45*s.* per ton at the pits; smalls, 32*s.* to 33*s.*; No. 2 Rhondda large, 34*s.* 6*d.* to 35*s.* 6*d.*; and No. 2 smalls, 25*s.* to 26*s.* per ton. The latest quotation for patent fuel has been 44*s.* to 46*s.* per ton. Special foundry coke for export has brought 62*s.* to 65*s.*; good foundry coke, 60*s.* to 62*s.* 6*d.*; and furnace coke, 50*s.* to 55*s.* per ton.

Western Trade Matters.—At a special meeting at Cardiff of the Tempus Shipping Company it was decided to split each of the existing 10*l.* shares in the Company into 10 1*l.* shares.—In 1912 the steamer Portsmouth, owned by McNeil, Hinde and Co., Cardiff, was sold by her owners for 16,500*l.* She was built at Sunderland in 1897 and was 3,600 tons dead-weight. She was renamed the Gaston Vigelund; within the last few days she has been resold for 105,000*l.*—Monmouthshire miners have formally protested against the imposition of income tax upon their wages; at a meeting held upon the subject a delegate said he was opposed to an income tax at all costs.—At a meeting of the Cardiff and Bristol Channel Shipowners' Association it was intimated that it is now proposed to make the maximum freight 60*s.* for Marseilles, 50*s.* for Algiers and Oran, 62*s.* 6*d.* for Genoa, and proportionately for other ports. For the present the scheme does not embrace a limitation of freights to Spain and Portugal, the Upper Mediterranean and Gibraltar. It was pointed out that as practically all the coal going to Spain, Portugal and Gibraltar, and also to the Upper Mediterranean, was for bunkering purposes, shipowners were deriving a benefit in cheaper bunkers at these destinations.—Messrs. Hutchinson and Co., Sir E. Balfour, Messrs. Dorman, Long and Co., and Messrs. Williamson and Co., are interested in a syndicate which recently purchased the Mannesmann tube works, Landore; the amount involved in the deal is further stated to be about 1,500,000*l.*—Notice to treat has been served upon the Cardiff City Council by the solicitors to the Cardiff Railway Company in respect of a proposed purchase of land at present in use as allotment gardens, at Waterloo-road tipping ground. The Cardiff City engineer (Mr. W. Harpur) states that it may be possible to effect an exchange of land in connection with the scheme of railway development which has given rise to the notice to treat. The town clerk and the city engineer are to report specially upon the subject.—Col. D. Davies, M.P., has written to the Machynlleth guardians in reply to a resolution passed with respect to an authorised increase of 2*s.* 6*d.* per ton in the price of coal. Col. Davies states that the matter was brought before the Government, which decided, after going into the facts, that the cost of getting coal in South Wales had increased 2*s.* 6*d.* per ton since last year and that a similar price increase should accordingly be granted. Col. Davies adds that he is in full agreement, however, with the spirit of the resolution and considers that means should be adopted to prevent the increase bringing hardships upon the poorer classes, who are already overburdened by the increased cost of the necessaries of life.—The exports of cargo coal from the British Channel in August were 1,356,061 tons, as compared with 1,248,897 tons in August, 1915 (shipments from Cardiff 681,664 tons, against 660,273 tons). Bunker coal was exported in August to the extent of 316,051 tons, against 287,739 tons (Cardiff, 218,371 tons, against 134,124 tons).—Writing to Sir T. Mackenzie, High Commissioner for New Zealand in London, the Lord Mayor of Bristol states that as the New Zealand Government is contemplating the establishment of a line of steamships to England, he should like a delegation of merchants and manufacturers to wait upon the High Commissioner in London to press upon him the claims of Bristol to selection as the English terminus of the line. The Lord Mayor added: "Seeing that the Hon. Sir James Carroll has notified his intention to visit Bristol in the near future, it may be that we shall have the pleasure of your company with him." Sir James Carroll is Commissioner of Stamp Duties for New Zealand, and he will be in Bristol September 28 and 29.—A suggestion has been made by the consulting engineer to the Clifton Suspension Bridge Company that Bristol should have a memorial of Brunel, so honourably associated with the early history of the Great Western Railway and the Great Western steamship.—A meeting of the Southern District of the Institution of Municipal and County Engineers was held at Bristol on Saturday, Mr. T. S. Pickering presiding. Mr. L. S. Mackenzie, Bristol city engineer, submitted an interesting paper on Clifton suspension bridge. Mr. Mackenzie stated that the floor of the roadway was laid with 5-in. creosoted Memel timber, grooved and tongued with iron; and upon this was laid another layer of timber placed transversely; the top layer, after being renewed once or twice, has now been replaced with Limmer asphalte. Mr. Mackenzie added that the weight of the chains was 554 tons, and that of the suspension rods, cross and longitudinal girders and roadway, 440 tons.—Lord Milner appears to have become a convert to a State control of coal mines, in order to regulate and organise the nation's coal output and to prevent overlapping by committees. Lord Milner considers it desirable accordingly that the whole control of coal mines should be vested in the Government; and that in order to secure this control with the least friction it is necessary to consult various bodies and representatives of various classes.

LARGE NEW HYDRO-ELECTRIC UNDERTAKING IN NORWAY.—The Bremanger Power Company has decided to exploit the Svelgvaadrag falls at Bremanger, which will have a capacity of 21,000 turbine horse-power. It is proposed to erect a factory for the manufacture of carbide and cyanamide, with a production of 30,000 tons of carbide per annum, one-third of which will be used in the manufacture of cyanamide. There is also some thought of taking up the manufacture of ferro-silicon. The whole installation is likely to be taken in hand at one time. The share capital will be 190,000*l.*, in addition to which a loan of 200,000*l.* has been provisionally arranged.

MACHINE SHOP OF THE BROOKE TOOL MANUFACTURING COMPANY, LIMITED, BIRMINGHAM.

(*For Description, see Page 271.*)

Fig. 25. General View at High Level.

Fig. 26. General View from Floor Level.

Fig. 27. Part of Raw Materials Store.

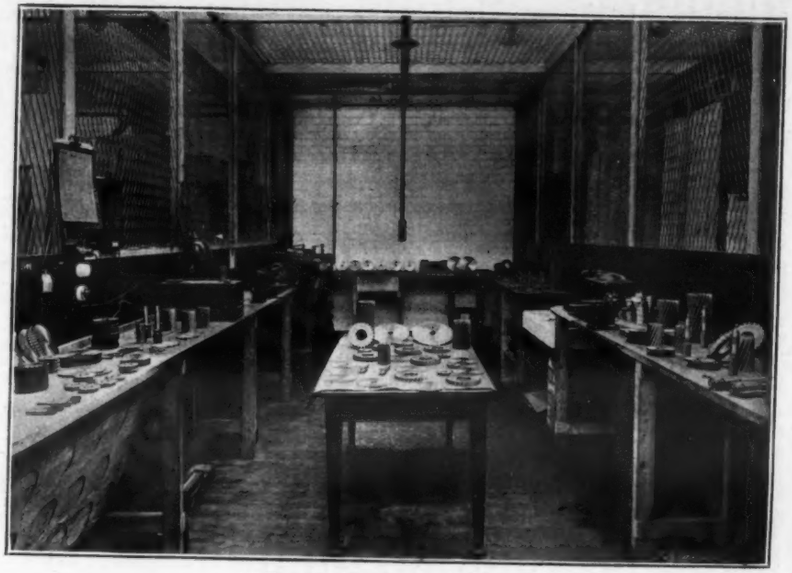


Fig. 28. Benches for Viewers.

1500-KW. GEARED TURBO-GENERATOR AT THE

CONSTRUCTED BY THE BRITISH WESTINGHOUSE ELECTRIC AND M

(For Description see Page

Fig. 34.

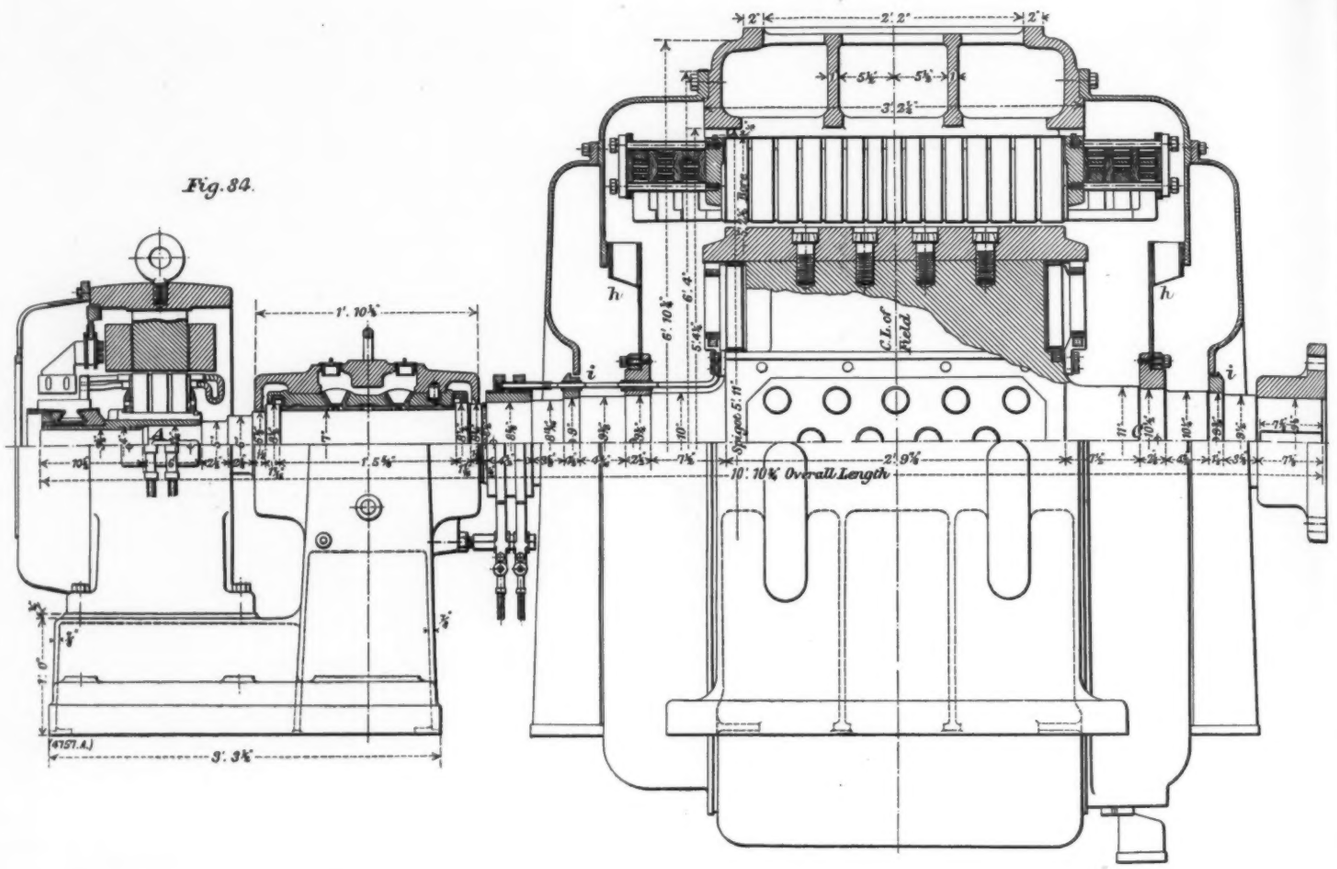


Fig. 35.

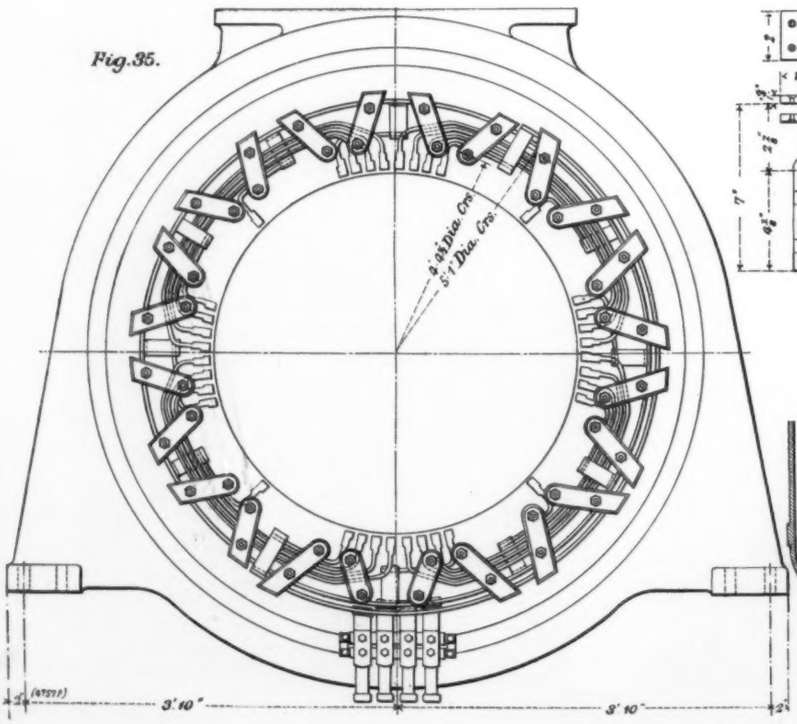


Fig. 38.

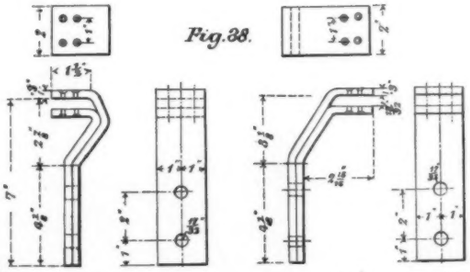


Fig. 37.

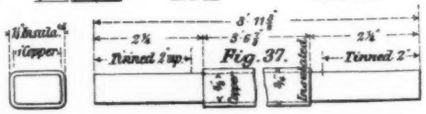
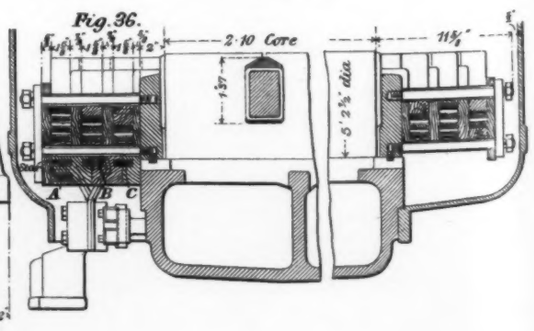


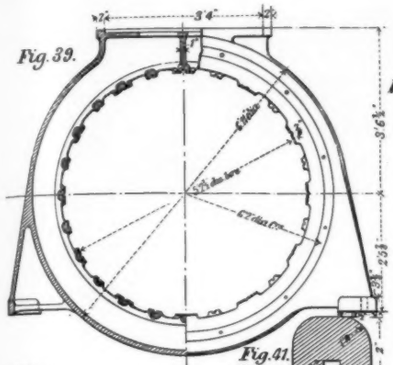
Fig. 36.

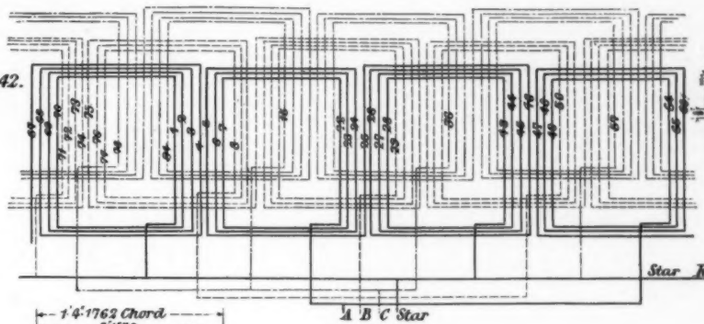


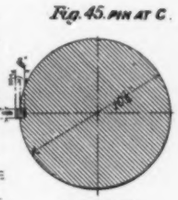
AT THE WESTINGHOUSE WORKS, MANCHESTER.

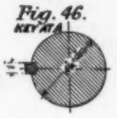
ELECTRIC AND MANUFACTURING COMPANY, LIMITED, MANCHESTER.

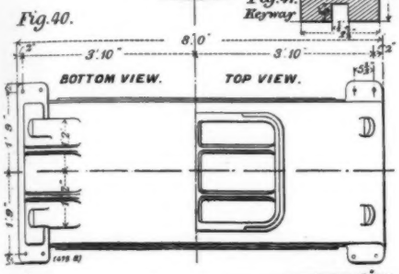
(Description see Page 278.)

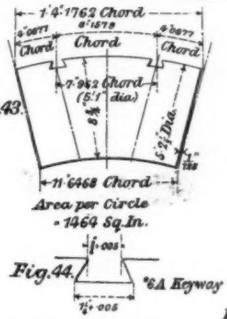


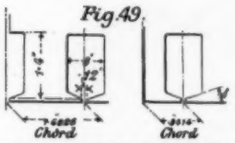


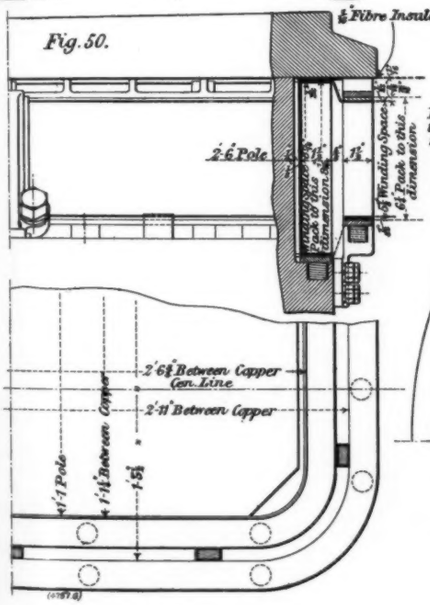


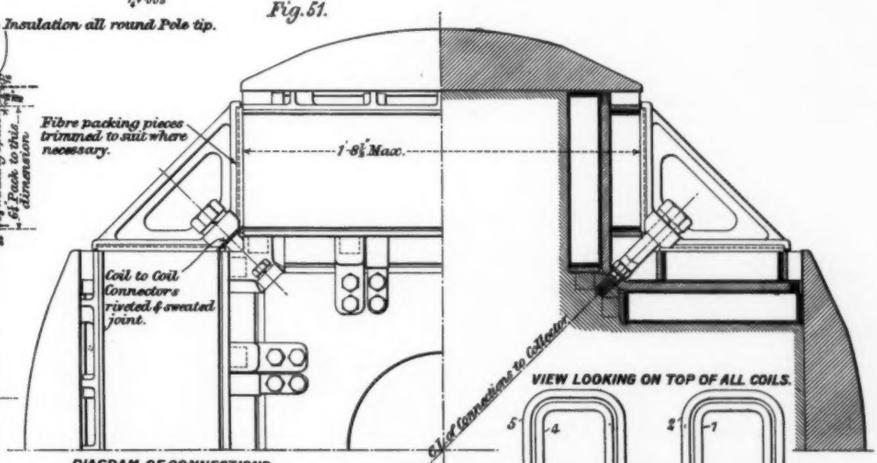


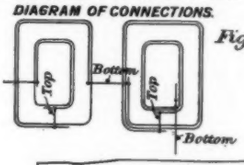


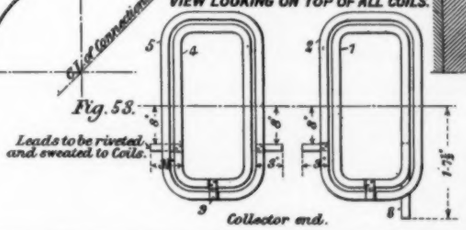


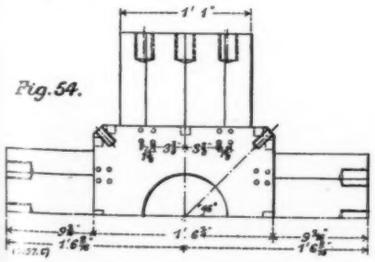


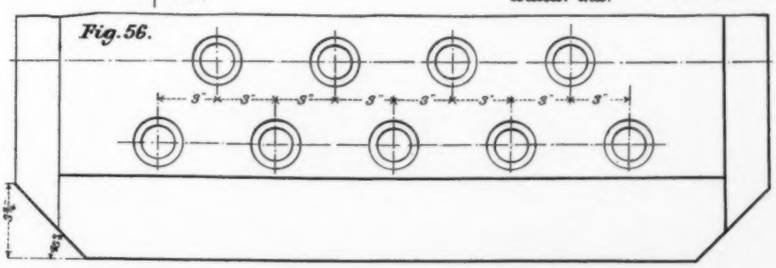


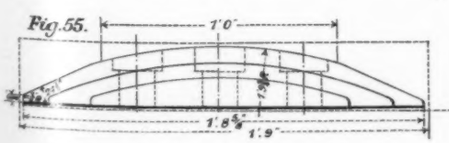


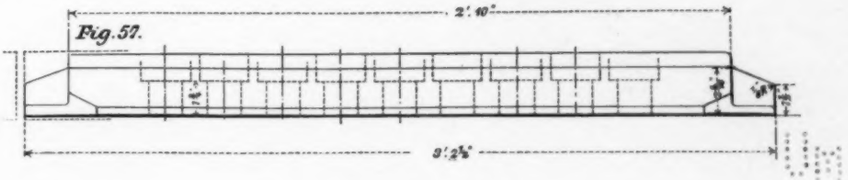












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Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

SUBSCRIPTIONS, HOME AND FOREIGN.

"ENGINEERING" may be ordered from any Newsagent in town or country and at railway book-stalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

For the United Kingdom	£1	15	6

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Thin paper copies	£1	11	6 ($7.65)
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Thin paper copies	£1	16	9
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Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "Union of London and Smith's Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C.

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We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS: "ENGINEERING," WESTRAND, LONDON.
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NOTICE OF MEETING.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS, LONDON (INCORPORATED).—Saturday, September 30, the opening meeting will be held at Caxton Hall, Westminster. Mr. V. R. G. Barnes, Graduate of the London and South-Western Railway, Eastleigh, will read a paper on "Locomotive Smoke-Box and Fittings." The chair will be taken at 2.30 p.m. by the President, Mr. R. E. L. Maunsell, M.A., M.I. Mech. E.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, SEPTEMBER 22, 1916.

THE PREPARATION OF SCHEMES FOR ARTERIAL ROADS.

WHEN the national interests permit, and party exigencies render possible, the Prime Minister will no doubt accede to the request that he should receive a deputation from the Second Main Conference on Arterial Roads, with a view to the discussion of the need for immediate action, not so much for actual constructional work as for the preparation by surveys and specifications for the construction of much-needed arterial roads in Greater London and throughout the United Kingdom. There is much preliminary work to be done, not only in determining the sources from which the required expenditure is to come, but in the choice of the routes of these new main thoroughfares, and in the fixing of the future building lines where property already exists. The Road Board, created for the improvement of the highways from the income derived from the petrol and other taxes, decided that no new work should be undertaken during the progress of the war. No one will cavil at this decision; the demand on the man power of the nation is too great to permit of the absorption of labour for undertakings which can easily be deferred. But the making of preparations for undertaking schemes belongs to a different category. There are many skilled civil engineers beyond the military age whose work is not at present utilised, and who could, therefore, with great national advantage, be engaged upon the preparation of all details, so that work could be commenced upon the conclusion of the war, when labour is available and is clamant for employment. The nation can quite afford to provide funds for the purposes named, and thus confer great advantage when it becomes necessary to absorb into the industrial army the men liberated from the fighting force.

The Improvements Committee of the London County Council have lately prepared an interesting report on this subject, in anticipation of the prospective interview with the Prime Minister and the President of the Local Government Board. Already it has been accepted that at least one new great arterial road shall be made through London with the co-operation of the Government or the Local Board. Sir George Gibb, Chairman of the Board, gave promise of a very considerable grant towards the cost of such a road from the City and East End of London to the western boundary of the county, by way of the Euston and Marylebone Roads, and here in itself is a scheme which ought to be prepared for immediate construction upon the conclusion of peace. Other projects are equally worth support, and there is much to be said for the view of the London County Council that where such roads, beginning within the metropolitan area, are conducive to national advancement when extended beyond that area, they should have the support of the State. There is no need to enforce the view that such great thoroughfares, constructed within the densely inhabited area of a city in order to increase transport facilities to the suburban and rural districts, impose on the city or borough authorities very great cost. A square yard of land in a town purchased for the construction of new arterial roads or for the widening of existing thoroughfares costs immensely more than the same extent of land in rural districts, and yet the gain in respect of improved transport facilities is widely enjoyed. It seems, therefore, that all such road improvements should come under a central authority, and that there should be some approach to allocation of expenditure according to the advantage accruing. Many conferences have had this question under consideration, and most of them have agreed that the Local Government Board ought to take some steps to ensure that the work undertaken will be of far-reaching advantage and that the expenditure involved shall be distributed over a correspondingly large area. Such conferences, too, desire to impress upon the Prime Minister and the President of the Local Government Board the importance of immediate action to prepare plans and preliminary estimates of the cost of such improvements, so that in the event of unemployment following the war, information as to useful outlets for labour may be readily available. That great good can accrue is beyond dispute, whether the new roads are within the metropolis or through rural districts. There is need for deliberation in both cases, but it is important that in populous districts the routes shall be determined with due regard to the prevalent flow of traffic, as well as to the demolition of unduly crowded areas and to the transfer of population to districts where the evils of overcrowding can be avoided. In rural districts there is need for the engineer with "an eye to country," so that gradients may be easy, the length of road shortened, and narrow necks, where rural property has been built without regard to the width of roadway necessary for "the rough" traffic, may be widened. Thus a scheme is required where even in remote wayside villages new building lines shall be laid down, even if property is not at once demolished, in order that such narrow necks shall be promptly widened out. The future, so far as industry is concerned, depends on a wider distribution of factories, on their removal to rural districts, where the workers can live in more hygienic conditions, with abundance of fresh air, greater facilities for recreation, and cheaper rents combined with a reduced cost of living. Great roadways can facilitate this work, in combination especially with the increase in mechanical transport which is certain to result from the immense improvement in motor-driven vehicles consequent upon the extension of army motor transport.

This programme is national, and the work must be organised, and at once, on a broad basis, without regard to the requirements of separate municipalities. The financial obligation must in the first instance be that of the State, although a proportion of it should ultimately be borne by the cities and towns. Already the Local Government Board are invested with considerable authority, while the Road Board has at least a nucleus of a fund which can be impressed into service for a great national advance. The result of the Government decision that the Road Board should not continue making grants during the war to the same extent as in previous years has been the accumulation of a surplus which, according to the report for the year ending March, 1915, exceeds 4,000,000*l.* No doubt some portion of that has since been expended in exceptional grants, but there still remains a considerable sum. The Board, it is true, have been engaged in supervising and constructing roads specially for military purposes, but the cost of these has come out of the war funds. There has been no legislation which would have the effect of appropriating or diverting from their original purpose the moneys in the hands of the Road Board at the end of March, 1915. Unfortunately, however, Parliament deprived the Road Board of its principal source of revenue, diverting the income temporarily to the Exchequer, namely, the proceeds of the motor-spirit duties and the carriage licences, but this did not affect the accumulated surplus. The diversion of this source of income, however, ought to be rectified as soon as possible, and the proceeds returned again to their legitimate purposes.

That great good has resulted from the operation of the Road Board can easily be established. For the four years ended 1915 the total yield of duties on motor spirits and carriage licences exceeded 5,000,000*l.*, and from this grants have been made or promised to the extent of over 4,500,000*l.*, in

addition to loans authorised and repayable. The consequence has been a great improvement of existing roads, but still more is required. If the funds available from the sources indicated are inadequate to do more than assist the reconstruction of heavily trafficked highways to the country, additional sources of assistance from national funds toward new road construction and road widening must be found, in the interests of industry, so that there can be that reconstruction of industrial factories which is almost essential for the regeneration of British commercial enterprise. The Road Board before the war arranged with a large number of highway authorities throughout the country for particulars of works of road construction and road improvement, estimated in the aggregate to cost over 2,000,000*l.*, to be carried out in the event of the state of employment for labour rendering it desirable to do so. Towards the cost of such roads the Board promised to contribute. If these schemes conform to the main idea of highways to suit industrial expansion and redistribution, the work of preparing the preliminary plans and specifications ought to be proceeded with at once. But apart altogether from the schemes already arranged, we are convinced that there are many others, and it would be to the national advantage were civil engineers employed now to prepare all details, so that work could be commenced immediately upon the disbanding of the Army. The Local Government Board ought to encourage highway authorities throughout the kingdom to make application for grants for such works, so that there could be co-ordination in the preparation of all schemes to ensure the maximum advantage, while the financial obligation incurred could be determined according to the local or national extent of the advantage accruing.

MECHANICAL TRANSPORT IN THE ARMY.

EVER since the South African War the use of mechanical transport had been under consideration by the military authorities. During that war, traction engines were used to a limited extent, but owing largely to want of experience this form of transport was not looked upon with much favour. Soon after the end of the war a small Committee was formed at the War Office to report on the possibilities of mechanical transport. Trials were arranged for steam lorries then available, and a few were subsequently purchased.

These vehicles, and some of the heavy tractors which were returned from South Africa, were taken into use for local transport at Chatham and Aldershot by the Army Service Corps early in 1903. A permanent Committee, composed of representatives of all branches of the Army, was formed at the War Office to deal with matters in connection with the subject. The first mechanical transport company was formed at Chatham. The headquarters of the company remained at Chatham, a detachment being quartered at Aldershot.

The headquarters of the mechanical transport were transferred from Chatham to Aldershot in June, 1904, and about a year later a good substantial workshop was constructed, and classes of instruction for officers and men were arranged at Aldershot. The use of mechanical transport vehicles increased very rapidly. Motor cars were taken into general use by the staff, detachments of mechanical transport and vehicles were sent to Ireland, Malta and Bulford. New companies were formed at frequent intervals; the use of mechanical transport at the annual manœuvres became general. Lorries were generally adopted in preference to steam traction engines, owing to advantage of speed and range of action without the disadvantage of requiring water. Petrol lorries were definitely adopted for food and ammunition supply organisation on the lines which had been adopted by the French Army. The consideration of a standard design of vehicles occupied the attention of the Mechanical Transport Committee, and many motor manufacturing firms started to supply standard vehicles to private users, the owners of such vehicles having the right to receive a substantial bonus from the Government under a subvention scheme.

At the outbreak of the war the number of vehicles owned by the War Office, and also of those over which they had a claim under this scheme, were entirely inadequate, and in consequence every available serviceable lorry in the country was impressed for military duty. Even then it was essential to arrange for large supplies of vehicles of foreign manufacture. It is for the reasons just mentioned, viz., of the enormous variety of pattern and type of vehicles, that we availed ourselves of the opportunity afforded him by the War Office authority to see the working of the organisation which has so successfully handled the supply of the equipment, spare parts, tools, &c., necessary for the efficient working of the vehicles.

It is difficult to grasp immediately the scope of the organisation included in the working of mechanical transport since the beginning of the war. The sub-divisions of the organisation are as follow:—Supply and equipment of vehicles, *personnel*, organisation of the transport operation service, repair and maintenance of vehicles. The entire organisation comes under the supplies and transport directorate of the Q.M.G. branch of the War Office.

The vehicles, on being taken over from the manufacturer, are assembled at a certain racecourse. The main depôt for the men is at Grove Park, the head-quarters for units mobilising are at Bulford Camp, and also camps in the vicinity of Grove Park, while the storehouses for the spare parts and equipment under what is known as the stores branch are located in London.

The war had been in progress more than a year before the new receiving depôt was formed. Previous to that new vehicles were delivered in Camberwell and other depôts, where they overflowed into the streets, to the inconvenience of the inhabitants. The new site offered two great advantages as a receiving station—space and numerous buildings of sorts, varying from the Royal box, the grand stand, luncheon rooms and bars, down to stables and forage rooms. Its great defect was the softness of the ground, which was rapidly churned into a sea of mud, so deep in places that no motor vehicle could make its way through it. In less urgent times the natural way would have been to have prepared a large, firm area before receiving the lorries, but under war conditions the two operations had to go on concurrently. The Army Service Corps took possession of the ground in the autumn of 1915, and soon the deliveries of motor vehicles began to flow in so rapidly that before many months had passed there were, at times, as many as 2,000 on the ground, while to add to the difficulties the weather was unprecedentedly wet. The first thing to be done was to lay down roads on an extensive scale, and also wide areas for storage purposes. This involved obtaining thousands of tons of materials, which had to be got where they could, as the railway company were not in a position to undertake any work that could possibly be avoided. Fortunately there was a good supply of ashes obtainable at the various gas works in the neighbourhood, and the service itself provided plenty of men and lorries, so that the firm area grew with wonderful rapidity, although not as fast as the demand upon it. Nevertheless, the unceasing effort told as the weeks went by, and presently there were plenty of good roads and a large area of solid ground on which vehicles could be parked. It was a big job, undertaken under adverse conditions, and carried to a successful conclusion with great rapidity.

The buildings in connection with the racecourse were, of course, quite different from those which would have been designed for the purposes of mechanical transport, but the modern soldier is an adaptable person, and he has contrived to make himself very much at home. The number of men on the job represents something like half a battalion, and although they invariably work long hours, yet they find some opportunities for relaxation. The officer in command has given much attention to making their lot healthy, and as pleasant as is consistent with the requirements of the service. A sewerage system has been put down and gas and water laid on. Stables, designed for the accommodation of racing horses worth thousands of pounds, make, when lighted and warmed, sleeping apartments far better than fall to the lot of most soldiers. The kitchens have been fitted with gas ovens, and completely organised, so that the food provided by the War Office can be well prepared and properly served. A luncheon saloon has been transformed into a reading and billiard room; space has been found for tennis, cricket and football, and on the river there are a couple of boats for the use of the men. In addition, a monthly magazine is published, illustrated by sketches and containing some very creditable verses, in addition to stories and examples of military humour, all contributed by the officers and rank and file.

Recreation, valuable as it is, must, however, be a very secondary consideration, for there is a constant stream of vehicles coming and going, involving an immense amount of work. Very many lorries arrive as chassis, and are despatched again to the body builders to be transformed for use as ambulances or for other purposes. All cars and lorries have to be properly equipped, to ensure their fitness for their purpose, with tools, lamps and the like. Large stores of accessories are maintained for this purpose, and in addition there are workshops at which minor repairs can be effected on the spot. If the vehicles were all of one make the equipment of them would be a fairly simple matter, but very numerous types are received, and their peculiarities have to be studied in fitting them out. The men have also to be trained in connection with the various patterns of mechanism, for although there is a general resemblance among motor cars, yet each make has its peculiarities, which must be known if the best results are to be obtained.

In spite of enormous difficulties, success has been attained, and the whole depôt runs without friction or mishap. Cars come, are inspected and equipped, and then, after a shorter or longer time, go away to the various fronts or to the great camps in this country. The stock fluctuates from week to week, according to the demand, but it is always equal to the demands of the War Office, which may be congratulated on the perfection to which this branch of its numberless responsibilities has been brought by its officers, N.C.O.'s, and men.

This depôt sees the commencement of the career of a car or a lorry, but, as many of our readers are painfully aware, a motor car is not only a complicated machine, but it is also far from robust. The weight has to be kept down rigorously, the speed of the engine is high, the gearing is subject to very severe stresses, and there is the constant risk of breakdown from nuts working loose, lubrication failing, teeth stripping, and the like. We do not know how many cars the Army has in use in this country, in Flanders, in France, in Greece, in Egypt, in South Africa, and in Mesopotamia, and if we did it might not be discreet to specify the number too definitely. But, according to American Consular Reports, France imported 23,000 commercial cars in 1915, in addition to those built in the country, so we must be quite safe in assuming, as a basis of argument, that we have some 40,000 to 50,000 vehicles in actual use. These include scores of different types, and in each car there are from 2,000 to 3,000 individual pieces. Most of them are far from the shops where they were built, and are subject to very rough usage due to bad roads and to military exigencies. That they are kept going satisfactorily is partly due to the splendid system of providing tools and spare parts which has been created by the Stores Branch of the Mechanical Transport Department, which in a few months developed the most wonderful organisation of stores which we have ever met. From these stores can be obtained duplicates of every screw, pin, cotter, bolt, nut, wheel, clutch, piston, cylinder, and what not, in every one of the 50,000 cars used by our Army in Europe, Africa and Asia. From this store all spare parts for M.T. vehicles required for units in the field are obtained by the stores at the bases of the British Armies in the field. How many individual varieties of parts are kept we do not know, but it approaches half-a-million. The whole organisation runs like clockwork, and affords the clearest evidence that it is not essential in British affairs to "muddle through," provided only that a job is put in the hands of men that understand the conditions. In this case engineers' work has been entrusted to engineers.

In such a complex organisation success depends

upon the adoption of a correct system by which every individual piece shall not only have its identity established, but shall have its capabilities and the range of its utility clearly defined. At a very early stage a series of handbooks was got out by the Stores Branch of the Mechanical Transport, each devoted to one part of a motor car or lorry. Let us take, for example, that pertaining to magnetos. In this there are given all the necessary particulars for each type of magneto, that is, whether it runs clockwise or counter-clockwise, whether the end of the spindle is taper or parallel, its length and diameter, the positions of the holes for the bolts, and the relations of these to the driving end. By aid of these it is possible to decide at once whether a given magneto can be applied to any particular car, and there is also given a list of cars to which each type of magneto can be fitted. In regard to chains a corresponding handbook contains sketches and particulars of all the chains in use, giving the sizes of links and pins and the wheels to work with them, and also the names of all the cars to which each type of chain is applicable. The same method is followed in relation to screw threads, valves, bearings, electric lighting plant, rubber hose, belts, copper and asbestos washers (there are thousands of sizes of these), ball bearings, lubricators, valve springs, clutch and brake linings, and many other parts. In addition to these articles, which may be common to several makes of cars, there are pieces which are more strongly individualised, such as cylinders, pistons, crank-shafts, wheels, clutches, differentials. Complete drawings exist of all of these, fully dimensioned, so that if a demand comes in from (say) Egypt expressed in an indefinite form it is possible at once to decide exactly which type answers to it.

Another kind of handbook takes the form of a synopsis of the parts of every type and make of car and lorry in the army. In it are particularised the dimensions of every piece of each car, and this serves as a check on the handbooks of fittings and components. Between the two it is impossible that any fitting, however small, should escape observation and record, and thus not be forthcoming when required.

The headquarters of the Stores Branch of the Mechanical Transport Department are in Pall Mall, and to that office come demands for new parts and spares, returns as to stocks received and issued, and other matters needed to enable the department to keep control of the enormous mass of *matériel* entrusted to its care. The premises, however, are not large enough to accommodate the officers in charge of the staff which is necessary to deal, in a clerical fashion, with the immense mass of material and correspondence which passes in and out day by day. There is, therefore, a large three-storey building in another part of London where the actual correspondence and book-keeping is carried on, and from whence blue prints and specifications are sent to all parts where our army is engaged. The number of employees runs into some hundreds, while the value of the plant of which they have to keep a minute account cannot be less than twenty-five millions sterling, and may be considerably more.

There are four large stores for motor car parts in London, each of very considerable size, and from them it would be possible to equip large numbers of cars on the shortest notice. It would not, we believe, be possible to build quite complete cars from the stores, because it is found that certain parts never need renewal unless the car is wrecked completely, in which case it is not worth while to repair it. Every piece of each car is not, of course, to be found in one of the stores. The buildings are graded, as it were, one taking large and heavy parts, such as chassis, wheels, cylinders, gear boxes and the like. Another takes parts of medium size, while a third contains the smaller pieces, which, of course, are by far the most numerous, in addition to tools and many miscellaneous items. Here are to be found acetylene lighting plants for breakdown jobs by the roadside, rope for hauling cars out of mud holes and swamps, crowbars for lifting them out of ditches, as well as picks and shovels for road-making. A great deal of repair work is effected abroad, and workshops, both permanent and travelling, have been supplied and fitted up for the purpose. Lathes, drilling machines, forges, rivet-heating fires and the like are all in demand, and as they wear out have to be repaired or replaced.

The fourth store is filled with rubber tyres, and is carefully located underground. While the other stores impress one with the wonderful complexity of modern warfare, this one brings home to the observer the enormous outlay involved. There are, of course, many varieties and sizes of tyres, but at a glance they look much alike. When built up in piles 6 or 7 ft. high, these piles extending up one alley and down another to a length of many hundred yards, it needs no calculation to prove that the value must run into hundreds of thousands of pounds. Even in this country, with excellent roads and careful handling, tyres are a constant source of expense to the car owner, even when they are solid. When the roads have been cut up for months and only repaired in a haphazard fashion, or when they are of the primitive construction which obtains in Eastern Europe, the wear and tear must be enormous. However, this Army Service Corps Branch of the Mechanical Transport can supply new tyres as readily as a baker can supply loaves of bread. The size of every wheel is known, as well as the mark of every type that will fit it, and hence it is a simple matter to comply with indents from every part of the world.

We have written at considerable length on this subject for two reasons. First, because there is an impression abroad that there is more muddle than method in our military organisation, and, secondly, because it is of great interest to engineers. As to the former we are not in a position to deal exhaustively, but the fact that this particular department of mechanical traction has attained to such a high degree of excellence suggests that there must be many others of high efficiency of which very little is heard. One squeaking bearing attracts more attention than a hundred silent cool journals, and it is therefore quite likely that if other departments of the War Office could be safely opened to the inspection of skilled observers the public would have material placed before them which would lead them to reconsider their opinions, and to admire the skill with which the vastest organisation ever known in this country has been called into being in the space of a few months. However that may be, the secret of success of the Stores Branch of Mechanical Traction is not far to seek. The officers have been selected from engineers who have joined the army during the war, and who came straight from the workshop and the drawing office. They changed their attire, but not their occupation, and consequently all they had to learn was the military side of their duties, which, of course, is not very much. Much of the work, however, is not mechanical, but of the nature of book-keeping, and therefore a part of the officers were selected from accountants, who were probably surprised to find that they were not exchanging the pen for the sword, as they imagined, and that their gaze, instead of being upon the tented field, was still directed to the ledger. At the details of book-keeping engineers are not usually expert, but they are, or should be, well acquainted with the principles, since it is almost impossible to make a works pay unless every detail of manufacture is placed in a methodical fashion before the clerical staff to be tabulated and indexed ready for reference. In the case before us the engineer and the accountant have worked together with the happiest results, but, of course, the heavier burden has rested on the former. The preparation and fitting up of the stores involved much thought, for it would have been bad engineering to incur lavish expenditure on buildings of which the usefulness was only temporary, while the efficiency of the arrangements had to be maintained at all costs.

The outstanding features of these stores are economy, cleanliness, order and method. Nothing has been spent on display. Alike in the clerical departments and in the stores themselves, the key-note is utility. The appliances are sufficient for their purpose, and no more. Typewriters, drawing office appliances, blue printing machines, card indices, and, in fact, all labour-saving devices, are in evidence everywhere. But there is no French polish and lacquer. Like the early Christians, the officers and men realise they have no "abiding city" in the department, and that a style of equipment which would be perfectly justified in a commercial establishment would be out of place there. The racks, no doubt, have cost thousands of pounds, but it would have been easy to spend double the sum on them, without any better result. They are all labelled and indexed, and no infraction of system is permitted. There is no scrap heap, nothing that corresponds to a suspense account, everything pertaining to a car has a niche of its own, and hence there is no confusion. The system includes all that is wanted, and consequently there is no individual who is indispensable, and whose absence would involve disaster. The best-managed commercial concern in the country could show nothing better.

ENGINEERING INDUSTRY MEETING AT THE MANSION HOUSE.

UNDER the chairmanship of the Lord Mayor of London, Sir Charles C. Wakefield, there was held at the Mansion House, City of London, on Wednesday, a meeting of engineers, at which three resolutions were passed, thanking munition workers, urging vigorous economic development of engineering after the war, approving the proposals of the Paris Economic Conference and recommending the immediate appointment of a Ministry of Industry in order to ensure their practical application and generally the advancement of the engineering industry. Practically all the speakers recognised, as the Lord Mayor put it, that the question now was, when are we going to stop talking and begin doing? It is marvellous, upon reflection, to discover that while there is so much agreement on the general line of action, so little action is being taken. Moreover, little that is new was urged in support of action along the agreed lines. No doubt there is likelihood of deepened conviction by the frequent repetition of sound arguments, but there is also the danger that the mere enunciation and reception of these views will be regarded as action which is operative.

We do not propose again to go through the whole scheme of necessary reform widely advocated for months past. What is needed is close application of science to every branch of engineering, or, as Sir Oliver Lodge urged, the appointment of advisory committees, similar to those now acting on war work, consisting of young men, whose eyes were more open to novelties, and who had greater energy and faith in the future, men who, he thought, might have remuneration at least equal to that of the parliamentarian. There is also, as Mr. W. W. Stokes put it, the need for the merging of individualism into the necessary combined action for the common good, first by those engaged in particular trades, by associations, and finally by national effort to advance trade. There is, again, the need, first, of more efficient producing appliances, and, second, of a fuller use of these, to the advantage of the worker as well as of the State.

But perhaps the most impressive note was the strong appeal made by Mr. G. H. Roberts, a labour representative in Parliament and, since the Coalition Government was formed, a Lord Commissioner of the Treasury. He was quite candid in his view that the trade unionists would insist on a return to the conditions of employment obtaining prior to the war, with all the restrictions of trade union regulations. But he pleaded, with a considerable degree of persuasion, for immediate action to ensure that after the war there should be industrial harmony. He was right in his contention that the degree of unity now prevailing had greatly influenced the volume of output required for the war and for the success of all our war operations. If the employed and employer classes could be brought together, and could arrive at a better understanding, he thought that there would be that increase in production which was essential in paying for the war. If effort were made to create such a better understanding he would go and urge amongst his class the duty of the workers, when they were well treated, to render of their best without regard to restrictive conditions. The three things that were to be aimed at were justice to the worker, fairness to the employer, and the duty of all to the nation. He, like all the other speakers, however, recognised the futility of merely passing resolutions. What is

needed in our opinion is a conference on a national basis between employers and workers, to see if, in anticipation of peace, certain standard principles cannot be accepted by both, in order to overcome those restrictive conditions which have been operative in the past in reducing the possible production of the nation.

NOTES.

GROWTH OF CRYSTALS UNDER PRESSURE.

IN 1853 Jean Lavalle stated that growing crystals exerted a linear pressure. Kopp, on the other hand, could not observe that a crystal had the power of raising itself by growing on the face on which it rested. Discordant observations were made by others. In 1905 G. F. Becker and A. L. Day described experiments according to which a crystal growing in a saturated solution at a constant temperature could raise a load of 1 kg., placed on the top of the crystal, through a height of several tenths of a millimetre; attempts to determine the linear force exerted per square centimetre failed, because the area of contact with the glass plate on which the crystal rested could not be measured. The experimental detail given was meagre, and, repeating the experiments in 1913, as far as possible under the same conditions, with the greatest care, W. Bruhns and W. Mecklenburg did not confirm the observations. Only the unloaded crystals grew. Late in 1914 Mr. Stephen Taber (*American Journal of Science*, xli, pages 532–556, June, 1916) took up the problem, mainly for the sake of its geological importance, apparently. He grew crystals of alum and other salts on glass plates, supported in dishes kept in desiccators; any load applied was put on a small glass plate resting on the top of the crystal; this had been done by his predecessors. But he had loaded crystals in one dish, unloaded ones in another, and loaded and unloaded crystals in a third dish. Under these conditions he observed that a loaded crystal did raise its load, but only when there was no unloaded crystal near it; Bruhns had had a loaded and an unloaded crystal next to one another, and, Taber suggests, had failed for this reason. When two crystals, similarly placed in the same saturated solution, are subjected to unequal pressures, the system is, he argues, in unstable equilibrium. Thus the solution may become supersaturated (and would hence crystallise) with respect to one crystal, while at the same time tending to dissolve a crystal which is under greater pressure. Pressure tends to increase solubility of a salt when there is contraction in volume, and most crystals dissolve in water with contraction, *i.e.*, the sum of the volumes of the water and of the salt is larger generally than the volume of the solution. But every big crystal, we thought, is only an agglomeration of small crystals, and we do not see why a big crystal should not be regarded as a unit in one respect, but as a unit with regard to a crystal next to it. Taber admits that some of his observations are not satisfactorily explained. Whenever a crystal grew in height, he found afterwards that a cavity had formed on its lower face (on which it was lying) even when that face had been quite plane, and there might also be a cavity on the top. In one case the lower cavity had a height of 0.54 mm., the upper a height (or depth) of 0.06 mm., and the whole crystal grew by 0.6 mm. in 15 hours; thus the total increase in height nearly balanced the total decrease in the cavities. In another case a crystal, 3 mm. thick, of potassium sulphate, placed between two glass plates which were pressed together by two rubber bands, completely dissolved in a few weeks in its own saturated solution. When a crystal grew in height, a kind of footstep, terraced often, was formed at its base, and that footstep grew only on its rim. The point is probably that there is a film of solution between the crystal and the glass plate on which it rests. That film is under the pressure of the crystal weight and becomes further supersaturated by capillary forces and adsorption. In the experiments, supersaturation of the whole solution was produced by slow evaporation or by cooling. Crystals of copper sulphate growing through porous clay walls or within thin glass bulbs (partly filled with crystal fragments and sand to start the crystallisation) crushed the clay or smashed the bulb in a week or so; the sulphate in the cracks was fibrous, resembling asbestos fibres in serpentine; this asbestos, Taber suggests, may have been formed in a similar way. We all know that freezing water will burst pipes, and if salts contract when dissolving in water, the solutions should expand when crystallising. We also remember that powdered substances combine and react with one another when highly compressed (Spring and others), and all these phenomena involve the little understood molecular forces.

BLASTING WITH LIQUID OXYGEN IN SALT MINES.

The war has advanced a type of blasting which was experimentally tried years ago, as soon almost as liquid air and oxygen became commercial articles, but which had so far not found practical adoption. Cartridges were charged with charcoal, and the carbon was impregnated with liquid oxygen; the ignited carbon then burned with explosive energy. But there were, of course, very great difficulties, which may be summed up in the statement that liquid air does not admit of being stored in closed vessels and evaporates rapidly when kept in open vessels. In 1915 experiments with liquid oxygen cartridges were energetically taken up by the saltworks at Winterhall, acting in conjunction with the famous potassium salt mines of Staassfurt and other localities, and considerable progress has been achieved, according to an illustrated article by Dr. Heberle, of Berlin, published in the journal *Kali* of January 15 and April 15, 1916. "Kali," we may add, means potash. The cartridges are simply made of texture, paper, or cardboard and are charged with soot or charcoal, mixed sometimes with other ingredients, or with kieselguhr and petroleum. The soot has answered well. A cap of fulminate of mercury is generally added for ignition; this cap should not be rigidly connected with the cartridge, to facilitate impregnation of the carbon. The Marsit cartridge does not need any cap. Ignition is by fuses or by electric wires; Dr. Hecker is said to have devised suitable ignition devices which do not require the instantaneous ignition of all the cartridges in a circuit. Impregnation of the precooled material may be effected either by pouring the oxygen into the cartridge through a tube of filter paper (Baldus and Kowatsch), or by immersing the cartridge in the liquid; the latter procedure is preferable. The oxygen should be of high concentration, 99 or 97 per cent. The immersion of a cartridge takes from 5 to 25 minutes. The experiments seem, at any rate, to have established several important facts. A cartridge can be so impregnated that it will still explode 10 or 15 minutes after being tamped in its hole; means have even been found by which cartridges could be impregnated at the surface and be taken down and used as much as three hours later. This is not considered important for salt mines, because the general conditions there demand that many appliances should be kept below. But the fact that not more than two men are required to look after up to 20 blasts would be important. Glass vessels or bottles were first tried for the transport of the liquid oxygen; but some unpleasant experiences were met with, and the transport vessels and immersion vessels are better made of metal. A hole may require 2 litres of liquid oxygen. The immersion cylinders at Winterhall have a diameter of 25 cm. and 38 cm. height; but big cartridges, 32 mm. in diameter, are sometimes used, and as many as five cartridges are fixed in one hole of a depth of 150 cm. This great depth of the boreholes is characteristic of salt blasting. Heberle estimates that one blast would cost 14s., counting materials and labour. That would not be cheap, and, he adds, moreover, that conditions may be less favourable elsewhere than they are at Winterhall. The actual dearth of explosives during war time may be a factor in these attempts. But there has been a good deal of experimenting on oxygen cartridges in this country as well, of course, and the point is to adapt the extra plant to the special conditions and to utilise it fully. Sawdust, we see from another German publication on mines, has not answered well as an absorbent for oxygen in cartridges, and it was observed in a limestone quarry that the percentage of carbon monoxide present in the air went up to 0.15 after firing two of these shots. That would be a grave matter.

THE INSTITUTE OF METALS.

THE autumn meeting of the Institute of Metals was held at the rooms of the Chemical Society, Burlington House, W., on Wednesday afternoon last, the President, Sir G. T. Beilby, F.R.S., being in the chair.

THE NEW PRESIDENT AND OTHER OFFICERS.

The nominations for officers during the coming year were read. It is proposed that Sir George Beilby shall continue to act as president, whilst Mr. L. Sumner and Professor Turner have been nominated as vice-presidents. The new members of council proposed are Messrs. W. H. Allen, A. Cleghorn, J. Dewrance, A. Philip, and S. Evered.

ARSENICAL BRASS.

A paper entitled "The Annealing of Arsenical Brass Containing 61 and 62.5 per cent. of Copper" was next read in abstract by Dr. W. Rosenhain. The authors were Messrs. C. H. Mathewson and E. M. Thalheimer, who had made their investigations in the Hammond Laboratory of the Sheffield Scientific School, Yale University. The research originated in an inquiry for a brass mixture suitable for making heavy tubes, using as one of the raw materials a brand of Lake copper containing 0.3 per cent. of arsenic. The material was required to withstand the process of hot-rolling a thick cake into a circular disc about ½ in. thick, which was then annealed and cupped, preparatory to being drawn into tubing. Hence, in addition to being capable of withstanding hot rolling, the alloy had to be very ductile when cold. The research consisted in comparing the working properties of the arsenical alloy with one having an equal proportion of copper, but nearly arsenic free. A third alloy was also investigated containing 61 per cent. instead of 62½ per cent. of copper. The analyses gave the following results:—

Mixture No.	Copper.	Arsenic.	Lead.	Iron.
	per cent.	per cent.	per cent.	per cent.
I.	62.41	0.024	0.022	0.03
II.	61.07	0.139	0.088	0.03
III.	62.49	0.120	0.017	0.03

In the mechanical tests made, after annealing and quenching at a variety of temperatures between 450 deg. and 750 deg. C., the arsenical brass was throughout found to be superior in elongation and in strength. Thus when quenched at 550 deg. C. the arsenical brass had a tensile strength of 49,400 lb. per sq. in. with a elongation of 77.5 per cent. in 2 in., the corresponding figures for the other alloy being 48,300 and 74.25 per cent. On the other hand, when annealed at a high temperature and immediately quenched, the contraction of area was a little lower in the case of the arsenical metal. The latter, however, was always the better when the cooling was less abrupt. The alloy with the smaller percentage of copper appeared less sensitive to variations in the rate of cooling. In general the conclusion reached was that for the particular purpose in view the alloy made with the arsenical copper was superior to that made with electrolytic copper. To get the best results the rate of cooling should, it was stated, not exceed 5 deg. C. fall of temperature per minute until the temperature fell to 550 deg. C., when the metal might be quenched. The structure of the alloys as developed by etching was found to accord closely with the mechanical properties throughout the whole series of the tests.

In calling on Mr. Hudson to open the discussion the president stated that both Mr. Hudson and Major Bengough were now working for the corrosion committee at the new research station at Brighton. In aid of these investigations the Advisory Committee of the Privy Council on Research had awarded a grant of 900*l*.

Mr. Hudson expressed his appreciation of the authors' work on the effect of heat treatment on the tensile strength of the alloys investigated. He was, however, a little doubtful whether the research was sufficiently comprehensive to establish complete confidence in arsenical brass. The tests certainly proved that the particular alloys investigated could

be worked both hot and cold and showed a good tenacity, but he certainly thought that the drop tests should have been included amongst the mechanical tests made. The micrographs given in the paper were excellent and showed that the changes in structure and the mechanical properties followed each other closely. He would, however, like to enter a protest against the unusual scale of magnification adopted, as he considered it most desirable that a standard scale should be followed in all cases. The banded structure shown in some of the micrographs was, he believed, never obtained with pure alloys, but was apparently very marked when arsenic was present, though even then it depended partly on the size of the section rolled. The authors attributed to the arsenic the power of retarding crystallisation, and a similar effect was produced by many impurities, as was well shown by micrographs of the zinc-copper-nickel alloys, where the nickel played a large part in hindering complete diffusion of the other constituents. It was possible, therefore, that all impurities had an effect of this kind. As for the laminar structure found in β, an appearance of this kind could be obtained when an excess of α crystallised out; but he had never himself found such a finely laminar structure as recorded by the authors.

Mr. Murray said that the authors deserved the thanks of the sheet rolling trade for increasing our knowledge of the properties and alloys of the Muntz metal type. Data as to non-arsenical alloys were, however, quite as important as those relating to arsenical brasses. The correlation established in the paper between the structure and the mechanical properties of the alloys was of particular value. Unfortunately, however, the alloys were not strictly comparable. The proportion of lead varied considerably, as the analyses showed, and further, the No. I alloy was not quite arsenic free. It was a great pity that more care had not been taken in this regard. It would also have been well to have included an investigation of the properties of an arsenic free alloy corresponding to alloy No. II. The investigation on the effects of arsenic was, however, particularly opportune, as manufacturers were at the present time compelled to use scrap brass and copper of very doubtful antecedents, arsenic being a common impurity. He must confess that his own experience had not enamoured him with arsenical brasses. He could only speak for such mixtures as were used here by sheet makers. These generally contained from 0.5 to 1.5 per cent. of lead, and if these contained even less than 1 per cent. of arsenic, low figures were obtained both for the ductility and for the strength. By very slow annealing no doubt the ductility could be improved, but the strength suffered. In actual practical work such sheets never gave as good results when cold worked as sheets containing less than 0.03 per cent. of arsenic. The sheets to which he referred contained lead and a little less copper (about 61 per cent.) than the authors' alloys. In fact, he had no experience with sheets containing less than 0.1 per cent. of lead. One point, however, was to be made, viz., that provided the arsenic were less than 0.03 per cent. the sheet was better than if the arsenic were entirely absent. Since, however, the scrap always contained arsenic, his firm were compelled to have nothing to do with copper containing arsenic, which, when lead was also present, led to failure. The authors stated that the annealing should be slow when arsenic was present, and this was borne out by practical experience. With respect to the micrographs, he would like to have some of these to a much larger scale, so as to be able to "see inside" some of the β produced in quenching from high temperatures. The paper contained no mention of any change of β in β' at 470 deg, but perhaps the violent reagents used for etching darkened this constituent too much. As for rates of annealing, a temperature fall of as little as 2 deg. per minute was not unusual in practice. Indeed, at times it did not exceed 1 deg. per minute, but the rate was by no means regular, and he thought the great pains taken to secure a regular rate of cooling were unnecessary. In conclusion, he suggested that English investigators might well take up the investigation of brasses containing both lead and arsenic. A single test for the latter was provided by the ordinary Muntz metal fracture test, which showed the yellow streak if arsenic were present. This was much less obvious, however, if lead were also present.

Professor Turner said he considered the paper an admirable example of how a practical problem should be studied. Having got an arsenical copper, it was required to produce a brass which would stand working, and apparently the product did stand the tests made. Nothing, however, was said as to whether these laboratory results were borne out in the practical use of the metal, and he agreed with Mr. Hudson that the mechanical tests should include experiments on the resistance to shock and to alternating stresses. He should have anticipated the increased tensile strength of the arsenical alloy, but not its greater ductility, although an analogy could be found in the nickel-iron alloys, in which the addition of the nickel increased both. He presumed that the limit of arsenic it was possible to use was low in view of the high melting-point of the arsenic-zinc compounds. He was also surprised that in the annealing tests the tenacity rose again in the case of the higher temperatures after first falling with low-temperature anneals, and he presumed this property could be taken advantage of in practice.

Dr. W. Rosenhain observed that the paper made a commencement to a very important research which was required on the effects of impurities in brass. The banded structure noted by the authors was quite analogous with what was observed in the case of steel containing phosphorus. The effect of the latter was either to diminish the rate of diffusion of carbon in iron or to diminish its solubility, and quite possibly the solubility of zinc in copper was diminished by the presence of arsenic and in a similar way the presence of arsenic in a brass containing lead might diminish the solubility of the latter. Hence it was not surprising that the properties were not the same when the brass contained arsenic only as when it contained both arsenic and lead. With regard to the authors' temperature measurements he doubted whether they were justified in considering their temperatures correct to 5 deg. C. Again, the specimens were thin sheets machined to size before annealing and tested after annealing. The authors did not say that any correction had been made for the consequent reduction of thickness by scaling. Further, the number of experiments appeared too limited and the results too few to afford more than a slender basis for the conclusions reached. For example, in one of their diagrams the authors showed two elongation curves crossing each other. This crossing was supported by the evidence of two points only, the distance apart of which was less than that of the admitted errors of observation.

Professor A. K. Huntingdon said he presumed that the material investigated had been successfully "cupped" in the shops, and it would be interesting to know its behaviour after despatch from the works. It appeared that the presence of a little lead altered the whole of the conditions. Hence a complete investigation of the effect of impurities in brass would involve an enormous amount of work beyond the capacity of either a private or a works laboratory, and the investigation should accordingly be supported by the Advisory Committee on research.

Allotropic Forms of Silver.

The next paper taken was contributed by W. D. Helderman, Utrecht University, Holland, and dealt with the "Allotropy of Silver." It was read in abstract by Sir Thomas Rose. In introducing his paper the author stated that he had been awarded a Carnegie research fellowship to carry out an investigation on the metastability of metals, and had originally intended to take iron as the subject of his investigations. Owing to the complicated character of the problem it was, however, finally decided to substitute silver for iron, as this metal was readily obtained in a very pure state. After reviewing the work of many former experimenters, some of whom claimed to have established the existence of three or four varieties of pure silver, the author described his own work. This consisted of very accurate determinations of the density of pure silver after heat-treating it in various ways. The results indicated, the author claimed, the existence of at least three varieties of silver, but it was not possible to obtain the forms each in a state of purity.

The conclusions finally arrived at were as follows: (1) Silver has a transition point at about 77 deg. C. (2) Pure silver consists of at least three allotropic forms. (3) All objects made of silver are in a metastable condition as a result of the retardation in the transition of the altered form. (4) All physical constants of silver (except the atomic weight) refer to indefinite mixtures of the different allotropic forms. New experiments are wanted to obtain constants for the different forms of silver in a pure state.

The discussion was opened by Dr. Rosenhain, who said he found a difficulty in treating the paper seriously. He had read a lot of the papers sent out from Utrecht on alleged cases of allotropy, but so far had failed to see how it was possible to base on the experiments there made the sweeping conclusions put forward. The whole evidence was provided by measurements on density and volume. Even supposing these changes were great, would it be necessary to attribute them to allotropy? Certainly, in the cases discussed by Dr. Helderman, there was no such necessity whatever. In the first place the material used consisted of turnings, so that the metal examined had been severely cold-worked. Consequently if Beilby's view was true—and it was generally accepted—we had in the amorphous phase produced by the cold working a complete explanation of the author's observations. The temperature at which the amorphous phase began to go back was quite low, and for such changes as were noted in the paper might well occur at ordinary room temperatures. In short, before any serious attentions could be paid to claims for allotropy based on density measurements, the experiments must be made with massive silver annealed at a high temperature so as to get rid of the amorphous phase. As for the changes observed at 25 deg. C., he thought the author's suggestion the least probable of any. As a matter of fact metals were not impervious to water. Thus, at the National Physical Laboratory, Mr. Sears had found that solid hammered and polished metal which it had been intended to use for standard weights would absorb an appreciable quantity of water, about one part in a million. The alloy in question consisted of equal parts of copper and nickel, but in spite of its solidity and smooth and relatively small surface, it took up by absorption or adsorption an appreciable amount of water, some of which was expelled at high temperatures. Such an absorption would readily account for all the author's results. Again, when the author found no appreciable E.M.F. between his supposedly different varieties of silver, he did not reach the obvious conclusion that there was no allotropy, but assumed that one of his modifications persisted in both. Again, the author's contention that the expulsion of gas from a metal must necessarily increase the density was untenable, since, if the metal occupied the same volume as before, the weight would be diminished by the gas lost and a lesser apparent density would naturally result. Indeed the author's final remark completely disposed of his own paper. He stated that all the physical properties of silver so far measured referred merely to indefinite mixtures of three allotropic modifications, and would therefore all have to be redetermined. As a matter of fact, about the most accurate and consistent determination yet made of any physical constant was the electrolysis equivalent of silver. This had been measured here, in Berlin, and in America, and the results were most consistent; and yet they were told that in such work they were dealing with indefinite mixtures.

Professor Turner said that he understood that Dr. Rosenhain did not question the accuracy of the author's measurements, but merely the conclusions arrived at. He himself had found no evidence in the paper of the three allotropic varieties postulated by the author. What were they? Did one exist above 77 deg. C., another at 77 deg., and a third below this temperature? It was obvious from the paper that there was no great volume change, and the calorimeter showed no important thermal change such as would lead to a belief in an allotropic variation. The turnings used by the author had been greatly stretched in the process of production, and rendered lighter, so that the

increase of weight found on annealing should be attributed to the fact that the metal had been cold worked, rendering it amorphous. Whether this was an allotropic change was a matter of definition, but any surface rendered smooth by buffing was rendered lighter than the mass of metal below. Dr. Rosenhain suggested that the silver had absorbed water in the author's tests. It should be noted, however, that the metal was immersed the whole time, and after a certain interval the effect of the liquid might not be very great.

Mr. Smith, who followed, said that Mr. Burgess, of the Washington Bureau of Standards, had observed that there was a complete analogy between the diseases of metals and of men, the closeness of which was enhanced by the fact that in both cases some of the diseases were imaginary, being due, in the case of metals, to what Dr. Rosenhain had called allotropy gone mad. The speaker found nothing in the author's paper which could not be explained by Stas's assumption of an absorption of gas by the metal. Silver, if heated in vacuum, lost, in fact, a considerable weight of gases, and this loss was not immediate but extended over a considerable time. As an extreme case, showing the necessity of caution in interpreting changes of density, spongy gold might be taken. Water-logged spongy gold had the same density as pure rolled gold. If dried and partially annealed the density fell to about 13, and if then left in water it rose to 14 or 15, but it never recurred to the original figure. To get it back to 19 it was necessary to re-melt it and hammer it out. He suggested, accordingly, that in the author's experiments the silver was water-logged up to 80 deg. C., at which temperature the imprisoned air on the pores to which the water had not excess expanded. In his view the ultimate test of allotropy was whether there were changes in other properties of the metal.

Sir George Beilby, in bringing the afternoon meeting to a close, said that the work done at Utrecht must be taken seriously and the matter thoroughly thrashed out.

(To be continued.)

LITERATURE.

The Manufacture of Carbide of Calcium. By CHARLES BINGHAM C.E. London: Raggett and Co. [Price 5*s.* net, bound.]

A FEW decades ago enthusiasts were going to revolutionise the whole illumination problem and to oust electric lighting, which was struggling into existence, by putting calcium carbide on the market at a cost of a few pounds per ton. These optimists and text-book manufacturers did their own pet scheme a great deal of harm. Carbide works grew up like mushrooms and decayed like mushrooms, and manufacturers were gratified to discover that the electric carbide furnace answered for the preparation of alloys as well, and that their carbide could bind nitrogen, though that nitrogen had first to be isolated.

At present further additions to the literature on calcium carbide might hardly appear to be wanted. But, nevertheless, books by expert engineers on their own specialities are always welcome, provided the authors do not shield themselves too much behind professional etiquette. Mr. Bingham gives, indeed, a great many valuable hints on raw materials, drums, labour and expense, as well as on other points, though he does not enter much into constructive detail. The illustrated remarks on carbon holders almost alone deserve commendation in this respect; most of the other diagrams on furnaces, arrangement of works and equipment, &c., are of a very general type. The work is primarily devoted to the commercial side, i.e., the manufacture of a product, Mr. Bingham says. It is not a systematic treatise, and is in fact described as a reprint of articles published in the *Acetylene Lighting and Welding Journal*, and brought up to date. References are very scarce, and there is little theory and much practical advice.

As regards electric furnaces, Mr. Bingham considers that in Europe practically tapped carbide (as distinct from ingot carbide) is alone made, and that the two chief rivals are the one-phase furnace with top and bottom electrodes and the three-phase (and also the single-phase) furnace with top electrodes only. Having worked with all kinds of furnaces, he prefers the former type as giving better results with good raw materials and good service, and the latter when raw materials are poor and the service is slack. On the other hand, the absence of a bottom electrode has the advantage that slags sinking to the bottom shunt themselves out of the electric circuit, whilst they have to be heated when the current has to force its way through the slags to the bottom electrode. Three-phase furnaces—really three combined furnaces, he argues—with three tapping holes, require as much labour as three single-phase furnaces, also on account of the regulation of their electrodes, unless automatic. Yet under certain conditions Mr. Bingham would advocate three-phase furnaces—for instance, for plants exceeding 3,000 horse-power. As regards ingot furnaces he acknowledges that the furnace of the Union Carbide Company of Niagara Falls is ingenious and superior as to output and in many other respects, except that the blocks have to be cleaned before crushing. There is no description of this type at all, however, and the name of the inventor (Horry) is not mentioned in this place, and in the index the name is misspelt Horrie. As to special linings for the furnace walls Mr. Bingham made experiments—runs of eight months—with two furnaces of equal type and capacity; the one was lined with refractory material, in the other the raw material served as lining; the former furnace gave a slightly higher output, but there was no decided advantage. Nor has Mr. Bingham any decided opinion as to continuous or alternating-current heating.

To avoid the attacking of the steel holder, in which the bottom electrode is embedded, by the molten mass—there is no mention of a conducting covering over the electrode—Mr. Bingham eliminated the bottom electrode by arranging the connections in a new manner—how, he does not explain. We have already referred to the holders for the upper electrodes. With regard to materials, the author rightly insists that it is not admissible to lump the impurities (for instance, the silicon or sulphur in the coal and in the lime) together in the admissible percentage of impurities. An inferior anthracite or coke cannot be made good by a particularly fine limestone, and 7 per cent. of ash may be tolerated in a coke, but not in an anthracite which is to be mixed with lime containing 1½ per cent. of silica.

The phosphorus scare Mr. Bingham considers badly exaggerated, as he was unable to observe or to produce spontaneous ignition of acetylene from a carbide impure with phosphorus; he overlooks that the phosphines are highly poisonous. He is no doubt right when he points out that, to secure a good acetylene generation, and to avoid overheating and polymerisation of the acetylene in the generator, plenty of water should be supplied, especially as the acetylene purifiers as a rule are very inferior. But he quotes verbatim a long report by Mr. F. B. Gatehouse (no date given)—the only authority whom he honours in this way—in order to demonstrate that some acetylene trouble was apparently caused by ammonia, the ammonia being, in Mr. Bingham's opinion, due to the formation of aluminium nitride (from alumina in the limestone) in the carbide furnace. Later on he states that methane and hydrogen are found in acetylene from calcium carbide; what he does not say is that aluminium carbide yields essentially methane, and that the different carbides behave differently when decomposed with water. That is an important point for the carbide industry, although it does not affect the furnace process.

On the whole, however, the chapters on Materials, Results of Manufactures, Working Results of Power Plants, Furnaces and their Heat Losses, Electrode Consumption, Packing, Dust, and Carbide Testing are very interesting, thanks to the eminently practical standpoint of the author. Heat Losses are discussed mainly after Hering. Like Lombardi and Scarpa, Mr. Bingham found by experimenting that the power factor is affected by what is going on in the furnace, regulation of the electrodes, electrolysis and the arrangement of the circuit; the last-mentioned cause, not by any means insignificant, he merely touches upon. The electrode consumption is much influenced by the form of the carbon with which the lime is mixed in the carbon; Mr. Bingham found coke in this respect decidedly superior to anthracite; on other grounds he prefers anthracite, on the whole, to coke, the moisture in the coke being a drawback. The lowest electrode consumption is generally conceded to the Horry furnaces, but they use Acheson graphite as electrode material. The packing of the carbide and the avoidance of dust are matters of considerable importance; most carbide works have their own drum-making plant, and what the author says concerning different styles of drums and their costs is quite as essential as lengthy discussions on current periodicity would be.

The drawbacks of the book are certain omissions, a very poor index, and a certain want of care which cannot be overlooked in practically reprinted articles stated to have been brought up to date. In the first theoretical chapter we read: "What causes the carbons to be eaten away so badly about a foot (30 cm.) above the lower ends? The carbons were entirely immersed in raw material to a depth of about a foot (30 cm.), as shown by a line in the diagram, so that the curve of the corrosion begins about 6 in. (15 cm.) below the surface of the mixture." The same chapter gives a wrong reference to Ruff and promises further allusion to Ruff's views on the reduction of CO in the furnace by the hydrogen of dissociated water vapour; that allusion we have been unable to find. To write "cu." instead of cubic may be the author's or the compositor's own way; to write "tonne" instead of ton, A for amperes and V for volts would be correct in French, of course; but to leave tonne in the English text—we do not speak of quotations—and to put a and v (instead of the capitals) does not suggest that anybody has taken the trouble to look over the proofs. Such things make the reader a little distrustful of the figures and tables and the many cost estimates. On the whole, however, we repeat, the carbide engineer will probably be glad to check his own views by the experience of Mr. Bingham.

BOOKS RECEIVED.

Cleator and Cleator Moor: Past and Present. By CÆSAR CAINE, Vicar of Cleator. Kendal: Titus Wilson. [Price 21*s.* net.]

The Theory and Practice of Modern Framed Structures. By the late J. B. JOHNSON, C.E., C. W. BRYAN, C.E., and F. E. TURNEAURE, C.E. In three parts. Part III. *Design.* Ninth edition, re-written by F. E. TURNEAURE and W. S. KINNE. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 17*s.* 6*d.* net.]

The Principles of Electrical Engineering and their Application. By GILBERT KAPP, M.Inst.C.E. Vol. I. *Principles.* London: Edward Arnold. [Price 15*s.* net.]

Welfare Work. Employers' Experiments for Improving Working Conditions in Factories. By E. DOROTHEA PROUD, B.A.(Adel.). With a foreword by the RT. HON. DAVID LLOYD GEORGE, P.C., M.P. London: Bell and Sons, Limited. [Price 7*s.* 6*d.* net.]

The China Year Book, 1916. With a Map of Mongolia. By H. T. MONTAGU BELL, B.A., and H. G. W. WOODHEAD, M.J.I. London: George Routledge and Son, Limited. [Price 10*s.* net.]

The Stability of Arches. By ERNEST H. SPRAGUE, Assoc.M.Inst.C.E. London: Scott, Greenwood and Son. [Price 4*s.* net.]

British Rainfall, 1915. By HUGH ROBERT MILL and CARLE SALTER. London: Edward Stanford, Limited. [Price 10*s.*]

Mechanical Drafting. By CHARLES B. HOWE. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 7*s.* 6*d.* net.]

Electric Switch and Controlling Gear. By CHARLES C. GARRARD, Ph.S., M.I.E.E., A.Am.I.E.E. London: *The Electrician* Printing and Publishing Company, Limited. [Price 15*s.* net.]

The Directory and Chronicle for China, Japan, Corea, Indo-China, Straits Settlements, Malay States, Siam, Netherlands, India, Borneo, the Philippines, &c. for the year 1916. Hong Kong and London: The Hong Kong Daily Press, Limited. [Price 30*s.* net.]

Forty-fifth Annual Report of the State Board of Health of Massachusetts. Boston: White and Potter Printing Company, State printers.

In the Royal Naval Air Service: being the War Letters of the late Harold Rosher to his Family. With an introduction by ARNOLD BENNETT. London: Chatto and Windus. [Price 3*s.* 6*d.* net.]

PERSONAL.—Mr. E. W. Abbott has taken over the management of the Newcastle branch of Messrs. Crompton and Co., Limited, at 21, Pearl Assurance Buildings, Northumberland-street, Newcastle-on-Tyne. He has carried out the electrical equipment of many important main winders, rolling mills, coaling cranes, large haulage gears, &c.

THE IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute was opened yesterday and is being continued to-day, in the Hall of the Institution of Civil Engineers. The president, Sir William Beardmore, Bart., occupied the chair at yesterday's meetings.

After the appointment of two scrutineers for the examination of the voting papers for the election of new members of the Institute (all of which were duly elected) the president announced that the Council had recommended the formation of committees dealing with matters connected with the development of industries. In this connection, the Council had suggested that the committees in question should be five in number, dealing respectively with mining and fuel, with pig-iron, steel, mechanical properties, and with physics and chemistry. The Council had further recommended that a Research Committee be also formed. The five technical committees above referred to would consist of eight members each, of which the Council would appoint one or two, the others being chosen by the members of the Institute. The committee members would be appointed for five years. The Research Committee also would consist of seven or eight members, the Council of the Institute appointing one or more.

The Council had also proposed that a new class of members be formed, called an "Associate Class," and consisting of students, pupils or apprentices to engineering and metallurgical works, and of persons associated with metallurgy. The associate members would be at liberty to assist at all the meetings of the Institute; they would receive all the publications, but would not have a vote. Later, the associate members could be transferred to full membership.

The following papers were then read and discussed:—

"Influence of Elements on the Properties of Steel," by Dr. J. E. Stead, F.R.S.; "Some Properties of Ingots," by Messrs. A. W. and H. Brearley. We shall deal with these and with the papers taken in to-day's proceedings in our next and further issues.

COMMONWEALTH WIRE CABLE WORKS.—The report on which the Australian Postmaster-General has decided to establish works for the manufacture of wire cable and metal rope states that an expenditure of 250,000*l.* will be needed to secure a turnover of approximately 1,000,000*l.* Positions will be found for 1,000 workmen. Not more than 10 men will be needed from overseas, and all the raw products necessary can be obtained in Australia.

THE LATE MR. RICHARD PRICE-WILLIAMS.—We regret to announce the death, on the 19th inst., of Mr. Richard Price-Williams, M.Inst.C.E., at the age of 89. It will be remembered that on February 18 Mr. Price-Williams was nominated by the Council of the Institution of Mechanical Engineers an Honorary Member of that body as an acknowledgment of the great services he had rendered to the profession, and was duly elected. In our next issue we shall refer at length to these services, which, owing to Mr. Price-Williams' great age, are not as well known by the younger generation of engineers as they deserve to be.

REVISED MAXIMUM PRICES OF PIG-IRON.—We have received the following *communiqué* from the Ministry of Munitions:—With reference to the Order made by the Minister of Munitions on July 7, 1916, bringing metallurgical coke, pig-iron and certain classes of steel under the provisions of Defence of the Realm Regulation 30A (see page 45 *ante*), the Minister of Munitions hereby gives notice that the general permit under the above Order dated July 7, 1916, is modified by the insertion in the Schedule thereto of the following revised maximum prices for the articles specified in substitution for the maximum prices contained in the Schedule as published and in addition to the revised maximum prices contained in the Notice of August 15, 1916:—

Derbyshire, Leicestershire and Nottinghamshire Pig-Iron.

Present prices per ton net f.o.t. Makers' works:—

	£	s.	d.
Forge	4	5	0
Foundry numbers	4	7	6

Price as amended per ton net f.o.t. Makers' works:—

	£	s.	d.
No. 4 forge	4	10	0
No. 3 foundry	4	12	6
No. 2 foundry	4	14	6
No. 1 foundry	4	16	6
Basic	4	17	6

The advance in prices to take effect as from July 19, 1916, until September 30, 1916.

DRAUGHTSMEN.

TO THE EDITOR OF ENGINEERING.

SIR,—There has been a deal of repudiation, and general terms of scorn have been used, and almost libellous innuendos directed at workmen and Trade Unions. There has also been much talk of status. I want enlightenment on the definition of status.

If it means money, then workmen are of a higher status than ourselves, and Trade Unionism has helped them to it. If appearance, then we are still worse off, for we need more fine clothes, but we have less money—a fool's estate! If it be manners and reputation, then surely the Association is the last thing we need, for in manners and deportment we surely want no lessons. For reputation—which I take to mean genius—intellectual intercourse, publication, and fame—they need no nurture, for they blossom with their own efforts.

We surely see no sense in whipping the unambitious into ambition, for it would make it all the more difficult for the ambitious, and an association would not be genuine. What is it? What is this key to status that the Associates seek to acquire?

Let us not look down on workmen and their Trade Unions, any more than we look down on the employer and his Trade Union—No! pardon, Employers' Federation.

I know and have known thousands of workmen, and have been one myself; in fact, my alternative occupation is the bench; and I think few engine draughtsmen have not served an apprenticeship to engineering, and I know ship draughtsmen envy us this. However, that is merely the circumstance of our launch into the world's work.

To my mind many hundreds of workmen are of the very highest status; it is the minority of blackguards that always damns the working class.

But make no mistake, it does not matter what class it is, the same number of blackguards are there; but, as everyone knows, money is as good as a pot of white paint. So let us not forget that we are closely allied to and are really an integral part of the working class, therefore let us not run the risk of being called the "Association of Snobs."

"E. D. O."

THE FUTURE OF AERIAL LOCOMOTION.

TO THE EDITOR OF ENGINEERING.

SIR,—Without in any way divulging State secrets perhaps you may kindly permit some views on progress in aviation. In the past ENGINEERING has proved a wealth of instruction to all aerodynamical students, whatever their particular principle may be. Who amongst us fails to recall Vogt's brilliant analysis of air rarefaction over the concave pinions of the bird. Horatio Phillips and his dipping edge, Sir Hiram S. Maxim with his strong advocacy of large diameter screws, and so many others one would like to mention. In military parlance, "Where are the boys of the old brigade?" One instinctively recalls such pioneers as Colonel Fullerton, Major R. F. Moore, S. H. Hollands, G. L. Davidson, Major B. Baden-Powell, P. Y. Alexander, and scores of others, some upholding wings or screws, others pinning their faith on the single aeroplane type. Each partisan of each principle knows fully those of other pioneers, and his favourite design, and whilst criticising them has yet not real animosity.

Whilst on this point I should like to refer to that fine old contributor and experimentalist Sir Hiram S. Maxim, who once announced his belief in the ornithoptere and his intention of constructing a machine which would embody no form of levers or connecting rods, the drive being direct. Naturally we were all on the tip-toe of expectation, but since then no further details have been forthcoming. Will Sir Hiram Maxim kindly state in these columns whether he ever carried out these experiments and whether successful or not? It is undoubtedly essential for some such aerodynamical scientist as Maxim to undertake and forward experiments both with the ornithoptere and helicoptere, for who would be bigoted enough to state that such work is now valueless? Who amongst us can in reality foretell what improvements in design and performance the flying machines of the future will reveal? That the present aeroplane has accomplished wonders none will gainsay, but its limitations are such that additional improvements would be welcomed. For instance, ascent and descent within a confined area, termed by some "direct lift," would be an immense stride forward, whilst a machine which could safely attempt the long cruise above the Atlantic or Pacific without undue fear of being ignominiously pounded to bits by the waves in descent would bring us close to the ideal "Clipper of the Clouds." Doubtless throughout the world men are quietly yet persistently working on the ornithoptere, helicoptere, or combination of both, and the ideal cruiser of the air without gaseous contents may be even now in embryo. Indeed, to my certain knowledge, here in England very careful methodical experiments on these lines are quietly progressing, and the cessation of hostilities will enable the aeronautical scientists to exhibit and publish their work.

Apart from this pioneer work in this direction, groundwork, although meagre in quantity, is yet highly encouraging. To briefly recapitulate the results of these sturdy efforts to conquer the ocean of air we have the ornithoptere of Stenzel, whose machine of 20-ft. span rose upward and forward by means of beating wings vibrating 84 strokes per minute, the power being 1½ h.p. The area of the mechanical bird spread some 87 sq. ft., the machine weighing 75 lb. In England we have the splendid work of Frost, Hutchinson, and D'Esterre, whose mechanical bird virtually copied each individual feather of its living prototype, the span being 20 ft., which sufficed to raise it some 2 ft. in each down stroke. No less than 232 lb. was thus lifted with the expenditure of only 3 h.p., the wings beating 100 strokes per minute. To Major R. F. Moore also belongs the honour of testing bat-like wings, each 7½ ft. in length, yielding a total superficial area of 45 sq. ft. Although only the comparatively small power of 1 h.p. was applied, this scientist recorded a maximum lift of 27 lb., whilst establishing the following laws: (1) properly constructed wings will produce a combined upward and forward thrust, (2) the thrust varies as the square of velocity of wing-tips, (3) power varies as cube of same velocity. With regard to the helicoptere, I have already referred to the magnificent work of G. L. O. Davidson in these columns, hence it will be conceded that in the light of these pioneer lessons hope springs eternal that the advanced homogeneously designed flying ship will soon be evolved in the near future of aerial locomotion.

Yours truly,
EDGAR E. WILSON (Group 23).

85, Glamorgan-street, Pimlico, London,
September 11, 1916.

THE QUEBEC BRIDGE DISASTER.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read with interest the article prepared at such short notice on the above, in last Friday's ENGINEERING, and note that a rocker is said to have failed. Was this the first part to give out? If a lifting jack refused its office, from leakage or other cause, one corner of the span would droop, the screw jacks, doing no more than follow up, would not save the situation; there might then be irregular stresses in the rocker bearings due to canting, with possible failure. Accompanying this there would probably be the twisting effects referred to in my previous letter, as any defect of reaction at one corner causes a corresponding defect at the corner diagonally opposite. On the other hand, if the lifting jacks were all working properly, the rocker failing might cause "droop," but hardly an unrestrained drop, though it may be noted that the quantity of metal in the hanging links appears to be sufficient to permit a free drop of about 2 in. before exhausting the balance of elastic resilience of the links in tension.

Yours truly,
W. H. THORPE.

60, Winsham-grove, Clapham Common, S.W.,
September 19, 1916.

AMERICAN SHIPBUILDING.—Norwegian shipping concerns continue to place substantial orders with American yards. A Stavanger shipowner has just closed with the North-Western Steel Company in Portland, Oregon, for four large, fast turbine vessels of about 9,000 tons each, sister ships to two already ordered. The price for the four vessels is stated to be 14,500,000 kr.; two have to be delivered September and November, 1917, the other two in January and February, 1918. This firm has now seven vessels ordered in America, with an aggregate tonnage of some 63,000 tons. A Hangesund owner has ordered two 9,000 tons steamers in the United States, to be delivered November and December, 1917. The same firm has a 7,000-ton steamer ordered in San Francisco, to be delivered December, 1916.

INFLAMMABILITY OF ILLINOIS COAL DUST.—Experiments made with 500 samples of dust from 100 representative coal mines of the State of Illinois show that this dust, when sufficiently fine, is highly inflammable and may, suspended in air, give rise to violent explosions. The research was conducted by Messrs. J. K. Clement and L. A. Scholl, junr., on behalf of the Bureau of Mines (Bulletin 102). The dust adhering to the ribs of most of the mines of the State was found to be inflammable, and in about one-fourth of the mines the quantity of rib-dust present in the entries was sufficient to form explosive mixtures with the air. Most of the road dusts were also found inflammable. The dust was, in the tests, injected into flasks which were provided with electrically-heated coils of platinum. The pressure of the explosion or combustion was determined; this pressure rose in the order: anthracite coal (pressure a small fraction of a lb. per square inch); semi-bituminous coal, bituminous coal, sub-bituminous coal (up to 10 lb. per square inch at a coil temperature of 1,200 deg. C.). The pressure generally rises abruptly at some particular temperature which the investigators call the critical temperature.

DANISH ENTERPRISE IN ICELAND AND GREENLAND.—The Danish copper mining in Greenland for the time being is being left in abeyance, not because there is no copper, but because another mining work is being pushed ahead by the same company, viz., that of graphite. Some valuable graphite deposits have been discovered at Amitrok, and some 800 tons have already been despatched to Copenhagen, where a factory has been erected for the handling of the graphite. A cleansing factory will be erected in Greenland, so as to reduce the bulk, tonnage being rather scarce in the Greenland trade. Other deposits of graphite have been discovered at Upernivik and Holsteinsborg, where mining may soon commence. The investigation of the Greenland mountains is about to be taken in hand rationally, as there is an idea of other valuable deposits being found there. Mining in Iceland is beginning to attract attention, and a second Danish syndicate has been formed, which has acquired extensive deposits of coal and asbestos in the vicinity of Staalfjeld, together with a neighbouring waterfall having a considerable capacity. Danish engineers have gone to Iceland to further matters.

STARTING DIESEL ENGINES WITH LOW COMPRESSION.*

Some Experiments on the Possibility of Working Diesel Engines with Low-Compression Pressures.

By Professor W. H. WATKINSON, Liverpool.

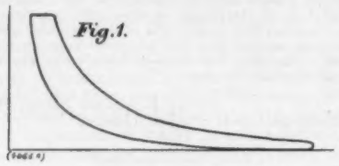
IN engines of the Diesel type, air flows into the cylinder during the charging stroke, and the fuel oil is not sprayed into the cylinder until the compression has been completed. In order that the temperature of the air may be raised during compression to the ignition temperature of the oil, the compression pressure is usually about 460 to 500 lb. per square inch, and it has hitherto been believed that this high compression pressure was necessary to effect self-ignition of the oil sprayed into the compressed air.

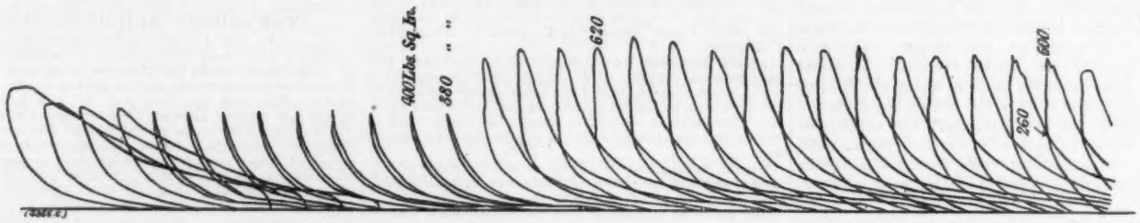
Fig. 1 shows the normal form of the indicator diagrams obtained from engines of this type. During the normal working of these engines the compression pressure is, approximately, the maximum pressure of the cycle; but during the starting of these engines explosions occur within the engine cylinder, and the pressure attained during these explosions may amount to 800 lb. per square inch, or more.

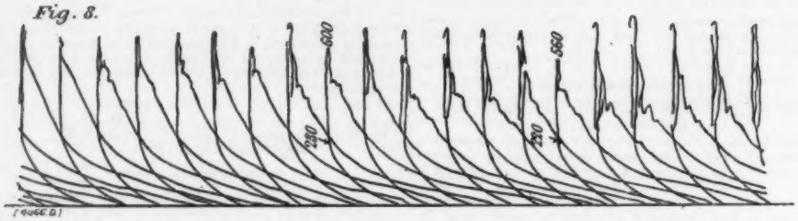
Fig. 2 shows a series of starting diagrams, from a 50-brake horse-power engine, which illustrate this point. The pressure attained in the first explosion is 800 lb. per square inch above atmospheric pressure, and considerably higher pressure has been recorded during starting under normal conditions.

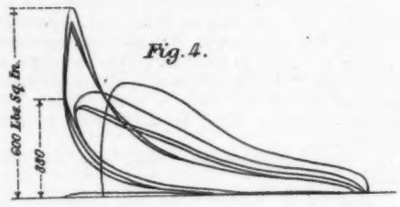
On account of the high pressures developed during the starting of these engines, also because of the higher pressures than those mentioned which are liable to be developed under certain abnormal conditions, it is necessary to make various principal parts of the engine much stronger than would be necessary for the normal maximum working pressure and, in consequence, these engines are heavier and more costly per unit of power than other types of internal combustion engines. The author has found that it is possible, in several different ways, to obtain ignition temperatures during compression without the use of high compression pressures, and the object of this paper is to describe the simplest of these.

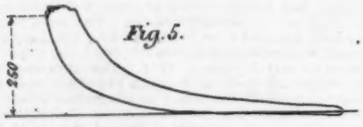
Fig. 3 shows a number of continuous diagrams from the engine after a slight addition had been made to it In all these diagrams the compression pressure is very much lower than the minimum pressure hitherto believed to be necessary for self-ignition. In the fourth explosion the compression pressure is 350 lb. per square inch, and the maximum explosion pressure in this case is 620 lb. per square inch. In the 16th explosion the maximum pressure is 600 lb. and the compression pressure is 260 lb. In the second row of these diagrams, ignitions are shown to be taking place quite regularly with a compression pressure of 220 lb. per square inch.

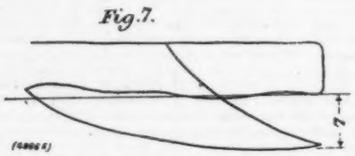


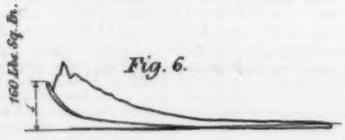












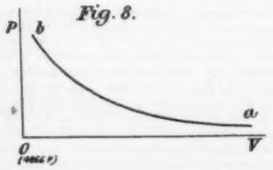


Fig. 4 shows diagrams for the starting air and explosions due to self-ignition, with a compression pressure of 330 lb. and a maximum explosion pressure of 600 lb. per square inch above atmospheric pressure. These diagrams were the first taken on a certain morning when the engine was first started from "all cold."

Fig. 5 shows self-ignition with a compression pressure of 250 lb. and with a maximum pressure only a little in excess of this.

Fig. 6 shows self-ignition when the compression pressure was only 160 lb. per square inch above atmospheric pressure.

Fig. 7 shows a light spring diagram, and indicates one way by which it has been possible to obtain ignition temperatures without a high compression pressure.

The equation to the compression curve (Fig. 8) is $p V^n = C$, and from this it follows that

$$\frac{T_a}{T_b} = \left(\frac{p_a}{p_b}\right)^{\frac{n-1}{n}} = \left(\frac{V_b}{V_a}\right)^{n-1}.$$

These equations show that the temperature at the end of compression, in any given case, depends on the ratio of compression and not on the magnitude of the pressure at the end of the compression.

In accordance with the experiments of the late Dr. Joule the temperature is not sensibly reduced by wire-drawing and, therefore, its temperature at the beginning of compression is independent of the pressure there, and the temperature of the air at the end of compression is independent of the compression pressure. It should be as easy to obtain ignition temperature by compression to two atmospheres as it is to obtain it in the ordinary way by compression to 34 atmospheres; but I have not yet made the experiment with such a low compression pressure.

I need only refer here to one application of the above method, although there are several that appear to be important.

To avoid the very high pressures obtained during the starting of such engines, it is only necessary to throw the mechanism operating the air admission valve out of action and then the spring on the valve spindle will automatically control the wiredrawing of the air admitted to the cylinder, and the maximum explosion pressure during the starting of the engine will then be limited to about the normal compression pressure, instead of its being 800 lb. per square inch, or more.

* Paper read before Section G of the British Association, September 7, 1916.

DRAUGHT CALCULATION, PANAMA CANAL.—The following formula, says *The Marine Journal*, New York, has been adopted by the Marine Division of the Panama Canal for calculating the draught of a ship in the fresh-water section of the Panama Canal: add one-fourth of an inch for each foot of draught in sea water. For all practical purposes this simple formula is very satisfactory, adds the journal. Accurate computation in this matter would require consideration of the displacement curve of a ship and the density of the water as determined by hydrometer tests. It is also pointed out that where the water plane area is approximately constant throughout the draught, the draught of a ship in fresh water is about 3 per cent. greater than in salt water.

GEARED TURBINES FOR AMERICAN DESTROYERS.—Geared turbine units, says *The Iron Age*, are to replace the direct-connected turbines of the destroyers Henley and Mayrant. Contracts for this work have been placed with the Westinghouse Machine Company, East Pittsburg. The machinery to be supplied will consist of two complete-expansion geared-turbine units of the impulse-reaction type, with Kingsbury thrust bearings and two geared cruising units. It is to be installed in the same engine room space and to connect with the existing propeller shafting and drive the propellers at the same speed as formerly. The Navy Department, it is understood, has adopted geared turbines because they are lighter and take up less space than direct-connected units, are better mechanically because of their small size, and require less steam at all speeds, and especially at cruising speeds, with a reduction in fuel consumption.

THE ARMOUR PLATE QUESTION IN THE UNITED STATES.—According to *The Iron Trade Review*, Cleveland, Ohio, Secretary Daniels will make an effort to purchase a private plant for the use of the Government for armour plate manufacture. It does not, however, seem at all likely that any of the companies will be willing to dispose of their armour plate works, which are an integral part of their plants and could not be satisfactorily operated by the Government under such conditions. On the other hand, numerous cities are clamouring to be selected as the site for the proposed Government works. These cities, adds the American journal, would be wiser if they entirely ignored this ill-advised project. Owing to the fight against efficiency which is being successfully carried on by labour unions in Congress, and for other reasons, the city which does not seek to have a Government plant located within its limits is likely to be more prosperous and happy than the city which invites the troubles that are likely to accompany Government ownership.

FUEL ECONOMY.

Fuel Economy.—First Report of the Committee, consisting of Professor W. A. BONE (*Chairman*), Mr. E. D. SIMON (*Secretary*), the Rt. Hon. LORD ALLERTON, Mr. ROBERT ARMITAGE, Professor J. O. ARNOLD, Mr. J. A. F. ASPINALL, Mr. A. H. BARKER, Professor P. P. BEDSON, Sir G. T. BEILBY, Sir HUGH BELL, Mr. E. BURY, Dr. CHARLES CARPENTER, Dr. DUGALD CLERK, Professor H. B. DIXON, Dr. J. T. DUNN, Mr. S. Z. DE FERRANTI, Dr. WILLIAM GALLOWAY, Professor W. W. HALDANE GEE, Professor THOS. GRAY, Mr. T. Y. GREENER, Sir ROBERT HADFIELD, Dr. H. S. HELE-SHAW, Mr. D. H. HELPS, Mr. GREVILLE JONES, Mr. W. W. LACKIE, Mr. MICHAEL LONGRIDGE, Dr. J. W. MELLOR, Mr. C. H. MERZ, Mr. ROBERT MOND, Mr. BERNARD MOORE, Hon. Sir CHARLES PARSONS, Sir RICHARD REDMAYNE, Professor RIPPER, Professor L. T. O'SHEA, Mr. R. P. SLOAN, Dr. J. E. STEAD, Dr. A. STRAHAN, Mr. C. E. STROMEYER, Mr. BENJAMIN TALBOT, Professor R. THRELFALL, Mr. G. BLAKE WALKER, Dr. R. V. WHEELER, Mr. B. W. WINDER, Mr. W. B. WOODHOUSE, Professor W. P. WYNNE, *and* Mr. H. JAMES YATES, *appointed for the Investigation of Fuel Economy, the Utilisation of Coal and Smoke Prevention.**

INTRODUCTION.

THE national aspects of fuel economy may be considered from two somewhat different standpoints, namely, (1) in view of the economic situation created by the war, which will necessitate the general adoption of more scientific methods in the future development and utilisation of the nation's mineral reserves, and (2) in view of that remoter, but possibly not far distant, future when our available coal supplies will be restricted by approaching exhaustion. In approaching its task the Committee decided that it could best serve the national interest by concentrating its attention upon the more immediate aspect of the problem.

It can hardly be questioned that the chief material basis of the great industrial and commercial expansion of this country during the past century has been its abundant supplies of easily obtainable coal, which, until recent years, has given us a position of advantage over all other countries. It is also equally true that we can no longer claim any advantage in this respect over our two closest competitors.

There can be little doubt but that up to the present we have been wasteful and improvident in regard to our methods of getting and utilising coal, and that not only are great economies in both these directions attainable, but also that the question of the general adoption of more scientific methods in regard to these matters is one of vital importance, in view of the trying period of economic recuperation which will immediately succeed the war.

For some years before the war the average price of coal at the pit-head had been decidedly on the up-grade, owing chiefly to deeper workings, higher wages, and greater precautions for ensuring the safety of the mines. The result of the great coal strike of 1912, and the legislation which it provoked, was to accentuate this tendency. And if, as seems probable, prices continue to rise for some time after the war at an accelerated rate, as compared with the pre-war period, the question of the best utilisation of fuels will be of increasing importance to the nation.

If anything ought to arouse public opinion to the gravity of the situation, it is surely afforded by the statistics published in the Report upon the World's Coal Resources, issued by the International Geological Congress in the year 1913. According to this estimate, the geographical distribution of the world's total possible and probable reserves of coal of all kinds available within 6,000 ft. of the surface (amounting in all to 7,397,553,000,000 metric tons) is represented diagrammatically in Figs. 1 and 2.

The fact that the available reserves of coal in Great Britain only amount to about one-fortieth, whilst those of the whole Empire do not amount to more than about one-fourth, of the world's estimated total, is one which ought to be brought home to everyone responsible for the economic development of our national and imperial resources, especially in view of the fact that the United States, whose competition in the immediate future will probably be much more severely felt than ever before, possesses more than half the estimated world's coal, and that also in regard to the two prime considerations of quality and cost of production she probably compares favourably with Great Britain and the Empire.

Moreover, it may be pointed out that in the United States both the Government and the University of Illinois have, for some years past, conducted numerous important chemical investigations and large-scale trials upon the character of the principal American coal seams and their adaptation for various economic ends, and that, in consequence, American manufacturers have at their disposal much more complete and systematic information about their country's coal resources than is at present possessed by their British competitors. Also, the United States Government, which is continually extending its policy of the conservation of its natural resources, has already taken legislative steps to prevent the premature exploitation of the coalfields of Alaska. Nor has Canada lagged behind her neighbour, as is proved by the recent exhaustive "Investigation of the Coals of Canada with reference to their Economic Qualities," conducted at the McGill University, Montreal, under the authority of the Dominion Government, and published in the years 1912 and 1913 by the Department of Mines in six imposing volumes. No such comprehensive investigations have ever been undertaken in this country, where they are much needed. The Committee is of opinion that the example of the United States and Canada might be followed with advantage to the industrial community by the Government of Great Britain, and that representations should be made with the object of inducing the Government to provide adequate funds in aid of further researches and investigations upon the chemical character of the principal British coal seams, the best means for their future development in the national interest, and upon problems of fuel economy, including the utilisation of all the by-products obtainable from coal.

The rapid increase during recent years in the world's demands for coal is shown by the following approximate figures covering the 10 years' period immediately preceding the outbreak of war :—

Year.	Approximate total Millions of tons.
1903	800
1908	1,000
1913	1,250

From these figures it would appear that, during the period in question, the world's demands have continuously increased at a compound interest rate of nearly 5 per cent. per annum. Another important fact is that these demands have been principally met by three countries, namely, the United States, Great Britain, and Germany, which, between them, have hitherto annually raised 83 per cent. of the total anthracite and bituminous coals consumed in the world. This being so, it is of interest to compare the relative rates of increase in the coal productions of these three countries during recent years, which may best be deduced from a comparison of quinquennial averages over a period of 15 years, from 1900–1914 inclusive, as follows :—

Fig. 1.

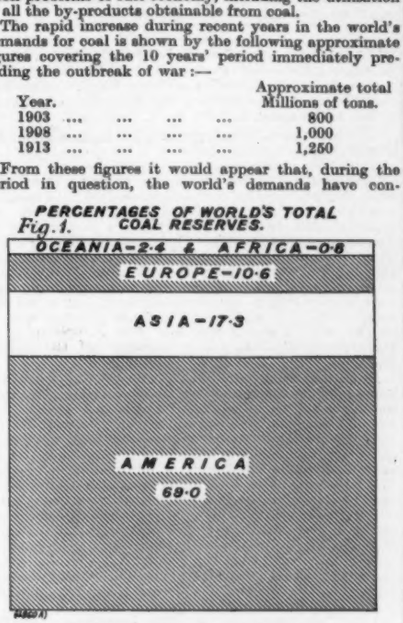
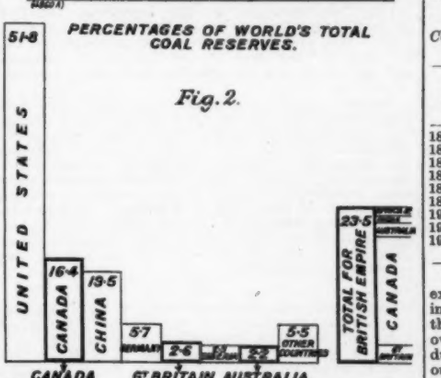


Fig. 2.



Coal Productions of the United States, Great Britain and Germany, Quinquennial Averages, 1900 *to* 1914.

Period.	Millions of Tons per Annum.		
	United States.	Great Britain.	Germany.*
1900–04 ..	288.2	226.8	112.5
1905–09 ..	400.5	256.0	139.8
1910–14 ..	519.2	269.9	166.3

* Excluding lignites and brown coals.

From these figures it may be inferred that up to the outbreak of the war the coal output of the United States was increased annually at a compound interest rate of about 6 per cent., that of Germany at a compound rate of about 4 per cent., whilst the British output was increasing at a compound rate of 2 per cent. only. During the period 1910–14 the United States produced nearly twice as much coal as Great Britain, and, assuming that these relative rates of increase are maintained after the war, it may be predicted that Germany's output of coal will overtake that of Great Britain about 20 years hence, when each country will be producing some 420,000,000 tons per annum.

The public cannot be too often reminded that not only is coal of prime importance as a fuel, but also that, when suitably handled by the chemist, it yields very valuable by-products, which are the raw materials of important industries. Thus from coal-tar, and other by-products of its distillation, are obtained the raw materials for the manufacture of both synthetic dyes and drugs and certain high explosives. Another important by-product obtainable is ammonia in the form of sulphate, which is chiefly used as a fertiliser in the production of foodstuffs. The use of artificial fertilisers, including ammonium sulphate, by agriculturists in Great Britain is still in its infancy, and the near future ought to see a large expansion in the home demands for nitrogenous fertilisers.

Among other products obtainable by the low-temperature distillation of coal are liquid hydrocarbons of the paraffin and naphthene series, and it is probable that large quantities of "motor spirit" could be manufactured in this country from coal. There is no doubt that we in this country have not been sufficiently alive to the importance of recovering such by-products from the raw coal raised in our mines, and that we have been very much behind Germany in this respect. Thus, for example, whilst in the coking industry modern by-product recovery plants had been universally installed years ago throughout Germany, we were, in 1913, still carbonising about 6,500,000 tons of coal annually for metallurgical coke in old-fashioned beehive ovens. Also, whereas our total production of ammonium sulphate from coal was in 1913 about 318,000 tons, Germany produced nearly 500,000 tons from a very much smaller output of coal.

The community needs to be reminded that, at least so far as this country is concerned, progress in fuel economy involves something more than increased thermal efficiency in respect of power production and of heating operations generally, important as these undoubtedly are. It also involves the whole question of the better utilisation of our coal, including the recovery of by-products and the consequent abolition of the smoke nuisance, which at present, directly and indirectly, costs the country many millions of pounds per annum.

There are two outstanding features in the history of the British coal trade to which the Committee desires to draw attention. One is the remarkably steady increase in the total output of our mines, which, since 1870, has been maintained at an almost uniform compound interest rate of 2 per cent. per annum, as the following table of quinquennial averages over a period of 45 years—1870–1914—shows :—

BRITISH OUTPUTS OF COAL, 1870–1914.

Coal Production in Great Britain—Quinquennial Averages, 1870 to 1914—*Millions of Tons per Annum.*

Period	Average Output.	Calculated at 2 per cent. Compound Interest.	Proportion of Total Output Exported.
1870–74 ..	121.5	121.5	0.13
1875–79 ..	133.6	131.1	0.146
1880–84 ..	156.4	148.1	0.172
1885–89 ..	165.2	163.5	0.200
1890–94 ..	180.3	180.5	0.220
1895–99 ..	202.0	199.3	0.237
1900–04 ..	226.8	220.1	0.27
1905–09 ..	256.0	243.0	0.31
1910–14 ..	269.9	268.2	0.326

The second feature is the phenomenal growth of our export trade, which, during the past 60 years, has increased something like twenty-fold, both as regards the quantities and the values of coal exported. Moreover, its value relative to other values exported has, during the same period, increased fourfold, until at the outbreak of war it constituted about 10 per cent. of our total exported values. We were then actually transacting over 70 per cent. of the total seaborne coal trade of the world. It must, however, be borne in mind that a considerable proportion of the exported coal supplies the needs of our mercantile marine.

Another circumstance which demands attention is the fact that the proportion of the coal raised annually in the United Kingdom which is exported has been doubled within the past 35 years, trebled within half a century, and is still increasing. Three factors have operated in producing this result. One is the proximity of the finest coalfields to our ports, another is the increased demands for coal from Europe and South America, while a third has been the phenomenal growth of our mercantile marine.

The foregoing figures for the total outputs of our mines by no means represent the real rate of depletion of our available coal reserves. A vast amount of usable coal is left behind in the mine because, under present individualistic conditions, it does not pay to bring it to the surface. A larger profit on the capital of a colliery company can often be earned by working the better classes of coal and leaving the less valuable grades underground. According to figures issued in the Report of the 1905 Royal Commission on Coal Supplies, this wastage amounted to nearly 25 per cent. of the total raised in the larger coalfields. The question of checking this wastage by finding out in what ways the less valuable grades can be turned to good account commercially is one of supreme national importance, and the Committee desires to draw special attention to it. Much of the coal now left behind in the mines ought to be converted into useful forms of energy and products for public purposes, and one of the most important aspects of the fuel-economy problem in Great Britain is the devising and organising of means for making it possible to raise this hitherto wasted coal at an economic advantage.

So much for the general statistics of coal production,

* Report submitted at joint meeting of Sections B and G of the British Association at Newcastle, Friday, September 8, 1916.

Coming now to the possible saving in the coal consumed annually in this country at the outbreak of the war (nearly 200,000,000 tons), it will be remembered that the 1905 Royal Commission on Coal Supplies found that the possible saving in our then annual coal consumption (167,000,000 tons) amounted to between 40,000,000 and 60,000,000 tons. There are many competent judges who consider that, notwithstanding the improved apparatus which has been put into use in the best factories throughout the country during the last 10 years, the average result obtained for the country as a whole still lags behind the best obtainable to-day in as great a proportion as it did in 1905. It will be the business of this Committee (1) to estimate as nearly as may be the present possible margin of saving, and (2) to point out the particular directions in which it can be attained from a national point of view.

ORGANISATION OF THE COMMITTEE'S WORK.

Having regard to the magnitude of its work, and the fact that the coal question is one upon which almost every branch of manufacturing and transport industry is dependent, the original Committee of 13 members appointed by the Association in October, 1915, decided to exercise somewhat freely its powers of co-option, so as to make a General Committee sufficiently large and representative of all the important interests involved.

For the more detailed and special study of particular aspects of the fuel question the enlarged General Committee resolved itself into the following five Sub-Committees, each of which subsequently elected its own chairman and, subject to its reporting from time to time to the General Committee, proceeded to make such arrangements as seemed best for the prosecution of its work :—

(*a*) Chemical and Statistical.
(*b*) Carbonisation.
(*c*) Metallurgical, Ceramic, and Refractory Materials.
(*d*) Power and Steam Raising.
(*e*) Domestic Heating and Smoke Prevention.

The General Committee next appointed an Executive Committee, composed of the Chairman and Secretary of the General Committee, the Chairman of each Sub-Committee (*ex-officio*), and 12 other members, which could meet frequently in London for the discussion of matters relative to the organisation and co-ordination of the work of the Committee as a whole, to deal with matters arising out of the proceedings of the Sub-Committees which might require immediate action or decision, and to receive and consider communications either from Government Departments or Technical Associations concerning subjects under investigation by the Committee.

The General Committee has met in London four times since its appointment in October, 1915, the various Sub-Committees have each met about four times since their formation in January, 1916, whilst the Executive Committee has met regularly on alternate Fridays since April 28 last. In all, 30 meetings have been held during the year. At the first meeting of the General Committee it was decided to organise a series of conferences of manufacturers and others interested in the fuel question in a number of the larger industrial centres, for the purposes of arousing interest in the work of the Committee, of inviting co-operation and suggestions from large users of fuel, and of educating public opinion in respect of the national importance of the question.

The following six conferences have already been held :—

Date.	Place.	Under the Auspices of
1915.		
November 19	Stoke-on-Trent	{English Ceramic Society. North Staffs. Mining Institute
1916.		
March 6 ..	London ..	London Section of the Society of Chemical Industry.
March 13 ..	Middlesbrough	Cleveland Institution of Engineers.
March 29 ..	Nottingham ..	Nottingham Section of the Society of Chemical Industry.
April 5 .	Manchester ..	Manchester Section of the Society of Chemical Industry.
April 6 .	Sheffield ..	Sheffield Society of Engineers and Metallurgists.

All but one of the above meetings were addressed by the chairman and one or more of the other members of the Committee, and the discussions which invariably followed were productive of valuable suggestions or information regarding local conditions which demand special consideration. It may be also mentioned that the chairman lectured at the Royal Institution of Great Britain, on Thursdays, January 20, 27, and February 3 last, on "The Utilisation of the Energy of Coal."

In March last the Committee was asked by the newly formed Central Coal and Coke Supplies Committee of the Board of Trade to make suggestions as to economies in fuel consumption which could be made at the present time, and, as the result of further correspondence upon the matter, it was arranged that Sir Richard Redmayne should act as the representative of the Board of Trade Committee on this Committee.

During the first year of its existence the attention of the Committee has been fully occupied with questions of organisation and a preliminary survey of the ground which must be explored later on. Already several important lines of investigation needing the co-operation of manufacturers have been instituted and are well in hand. But the returns are in most cases not yet sufficiently complete to justify publication in the Report, and, in view of the importance of the interests and issues involved, the Committee feels that it would be premature to issue any detailed report on particular aspects of the fuel question until its inquiries have reached a more advanced stage than at present.

The Committee recommends that it be re-appointed to continue its investigations, as outlined and foreshadowed in this Report, and, in view of the considerable expense involved in carrying out such work, it feels justified in asking for a grant of 100*l*.

APPENDICES.

THE WORK OF THE SUB-COMMITTEES.

The following memoranda concerning the work of each of the five Sub-Committees will sufficiently indicate the various matters which are at present chiefly under consideration, and the arrangements which have been made for their future investigation.

A.

Chemical and Statistical Sub-Committee.†—Dr. J. T. DUNN (*Chairman*), Professor P. P. BEDSON, Dr. W. GALLOWAY, Professor THOS. GRAY, Mr. T. Y. GREENER, Professor L. T. O'SHEA, Sir RICHARD REDMAYNE, Dr. A. STRAHAN, and Dr. R. V. WHEELER.

The Sub-Committee is preparing a memorandum and a bibliography upon the question of the chemistry of coal, and is of the opinion that the time has now arrived for a re-investigation of the subject in order to clear up a number of outstanding points connected with the chemical constituents of coal, their mutual relations in the raw material, and their influence upon the character of the various products obtainable by its distillation or oxidation. Accordingly, some of its members have undertaken experimental work, partly on new lines and partly by way of check repetition, with the object of providing a basis for a more complete attack upon the subject in the near future. A group of research assistants is already working on the problem under Professor Bone's direction in the Department of Chemical Technology of the Imperial College of Science and Technology, London.

As an important part of the work, the Sub-Committee hopes later on to organise systematic investigations upon the chemical character of the principal British coal seams. Such an undertaking would, however, involve considerable labour and expense, and the prospect of achieving any useful result will depend entirely on the amount of funds which may be forthcoming in support. The Sub-Committee is of the opinion that the resources both of existing laboratories which have been established within recent years in this country for the special investigation of fuel problems, and of other laboratories where the technique of the subject has been developed, might be utilised more than they are at present in this connection, and that the time is ripe for the organisation of a scheme of systematic co-operative research, aided by national funds, in which all such laboratories may participate.

The Sub-Committee is also compiling statistical information relative to the different purposes for which coal is used, and has entered into communication with the Board of Trade upon the question, but the collection and analysis of such statistics has been greatly impeded by the war.

Another important matter into which the Sub-Committee proposes to inquire is the amount of wastage due to coal which, for one reason or another, is at present left behind in the pits. Part of such wastage, for example, that due to the occurrence of faults in the coalfields, is unavoidable, but when all such allowance has been made, there undoubtedly remains a large wastage in working which might be and ought to be avoided. A memorandum is being prepared on the reduction of such wastage by the adoption of hydraulic stowing, a practice which, although in vogue on the Continent, has not yet been established in Great Britain.

B.

Carbonisation Sub-Committee.—Mr. T. Y. GREENER (*Chairman*), Professor P. P. BEDSON, Sir G. T. BEILBY, Mr. E. BURY, Dr. CHARLES CARPENTER, Dr. J. T. DUNN, Professor THOS. GRAY, Mr. D. H. HELPS, Mr. C. H. MERZ, Professor L. T. O'SHEA, Dr. J. E. STEAD, Mr. G. BLAKE WALKER, and Dr. R. V. WHEELER.

The total amount of coal carbonised in this Kingdom for the manufacture of metallurgical coke or for towns' gas in the year 1913 was probably about 35,000,000 to 40,000,000 tons, or approximately one-fifth of the total home consumption of coal for all purposes.

According to a recent Parliamentary Return relating to all Authorised Gas Undertakings in the United Kingdom, the total quantity of coal carbonised for towns' gas by 831 such undertakings in the year 1913 amounted to 16,971,724 tons, from which 195,826,000 cub. ft. of coal gas were produced, or say, on the average, about 11,500 cub. ft. per ton of coal carbonised. There are a number of gasworks not included in this Parliamentary Return, and it is computed that they carbonise about 1,250,000 tons of coal per annum. Thus the total coal carbonised in gasworks throughout the kingdom in the year 1913 would be about 18,200,000 tons.

The amount of ammonium sulphate produced by gasworks in that time in the United Kingdom was officially given as 182,180 tons, which on the above basis would represent an average yield of about 22.4 lb. per ton of coal carbonised.

No such complete returns are available in relation to the manufacture of metallurgical coke, but the amount of coal carbonised for this purpose in 1913 probably did not fall much short of 20,000,000 tons. Of this coal, the larger proportion was carbonised in by-product ovens, producing, besides coke, tar, benzol, &c., some 133,816 tons of ammonium sulphate. Assuming an average yield of 22.5 lb. of ammonium sulphate per ton of coal, it would appear that approximately 13.3 million tons were carbonised in by-product ovens, and probably about half that amount in beehive ovens.

† The Chairman and Secretary of the General Committee are *ex-officio* members of each Sub-Committee.

With regard to the coking industry, the Sub-Committee has already undertaken steps to secure a complete return of the number of by-product recovery ovens installed and working throughout the country, the character of each installation (whether waste heat or regenerative), its coking capacity, the description of the recovery plant connected with it (whether direct or indirect), the number of benzol recovery plants in operation, the quantities and yields of the by-products obtainable, and the purposes for which waste heat and surplus gas are being employed. When completed, this return will enable the Committee to arrive at an approximate estimate of the margins of possible economies in the shape of improved utilisation of the coal carbonised which can now be effected in the coking industry and the directions in which further progress is likely to be made.

A memorandum is also in course of preparation describing the more important developments of the by-product coking industry, from its inception until the present day.

With regard to gasworks practice, inquiries have been instituted regarding the present practice in connection with the manufacture of towns' gas, and for this purpose the Institution of Gas Engineers is officially represented on the Sub-Committee. It is also intended later to consider the question of low-temperature carbonisation from the point of view of its possible economic results, but up to the present time so little authentic information is available that the Committee would welcome the offer of proper facilities to enable them to investigate the matter.

C.

Metallurgical, Ceramic and Refractory Materials Sub-Committee.—Dr. J. E. STEAD (*Chairman*), Mr. ROBERT ARMITAGE, M.P., Professor J. O. ARNOLD, Sir HUGH BELL, Bart., Mr. E. BURY, Sir ROBERT HADFIELD, Mr. GREVILLE JONES, Dr. J. W. MELLOR, Mr. ROBERT MOND, Mr. BERNARD MOORE, Mr. BENJAMIN TALBOT, Mr. B. W. WINDER, and Mr. H. JAMES YATES.

The amount of coal consumed in metallurgical, ceramic, refractory materials and cognate industries probably amounts to approximately 20 per cent. of the total home consumption. Of this, probably about three-fourths must be debited to the iron and steel industries.

The Sub-Committee has taken steps to ascertain from some of the larger manufacturers data which will assist it in determining the actual amount of fuel which is being used on the average in the manufacture of the various brands of pig-iron, spiegeleisen, ferro-manganese, &c., throughout the Kingdom. A memorandum is in preparation concerning the heat balance of a blast furnace of modern construction for the manufacture of Cleveland No. 3 and other pig-irons, and a description will be given of the best methods now available for the utilisation of the surplus gases from such a furnace. Inquiries are also being made as to the results of the application of dry air to blast furnaces.

In like manner a series of questions relative to fuel consumptions in steelworks has been prepared for circulation among the larger steel plants in the Kingdom, with a view to ascertaining both the present average consumption and the directions in which further economies may be looked for in the near future. In this connection the Sub-Committee will endeavour to draw up a statement as to the best lay-out and arrangement of a combined by-product coking, iron-smelting, and steel-making plant from the point of view of utilising as completely as possible surplus gases and waste heat, and thus realising the maximum fuel economy in the heavy-steel industry.

Similar inquiries will be instituted in regard to present-day practice and results in relation to (1) iron foundries, (2) manufacture of wrought iron, and (3) specialised steel industries.

Two members of the Sub-Committee specially connected with the ceramic industry have undertaken to prepare a memorandum showing the average present practice and the possible margins of fuel economy in relation to that industry, and information is invited by the Sub-Committee relative to glassworks and brickworks.

The Sub-Committee desires to state that all information communicated to it by individual manufacturers will be regarded as confidential,* and will be used merely as a basis for arriving at an approximate estimate of the present average fuel consumption per unit of output in the particular industry to which the information relates.

D.

Power and Steam Raising Sub-Committee.—Mr. C. H. MERZ (*Chairman*), Lord ALLERTON, Mr. J. A. F. ASPINALL, Dr. DUGALD CLERK, Mr. S. Z. DE FERRANTI, Sir ROBERT HADFIELD, Dr. H. S. HELE-SHAW, Mr. W. W. LACKIE, Mr. MICHAEL LONGRIDGE, Mr. ROBERT MOND, Hon. Sir CHARLES PARSONS, Professor RIPPER, Mr. R. P. SLOAN, Mr. C. E. STROMEYER, Professor THRELFALL, Mr. G. BLAKE WALKER, and Mr. B. W. WOODHOUSE.

The special duty of this Sub-Committee is to investigate the economies in fuel which would result from the use of improved methods, and it has been decided to deal with the subject under the following heads :—

1. To consider (*a*) the amount of fuel consumed, and (*b*) the corresponding power developed in the United Kingdom under the following heads : Factories, Mines,

* It is suggested that all such information should be sent in the first instance to Professor Bone (Chairman of the General Committee), at the Imperial College of Science and Technology, London, who will classify and summarise it under either alphabetical letters or numerals in such a way that the names of the manufacturers or firms concerned will not be divulged to any of the members of the Committee.

Railways, Ships, and Steam Raising for other purposes than power.

2. To consider the present position of central electrical power plants and gas undertakings as regards power supply.

3. To discuss the relative merits of the present methods for producing power by steam, gas, oil, and petrol engines respectively.

4. To investigate the possible saving of fuel which might be effected (*a*) by improved plant, (*b*) by greater centralisation of power production, (*c*) by co-ordination with metallurgical and other manufacturing processes, (*d*) by some measure of public control, (*e*) by better supervision, and (*f*) by the use of inferior grades of fuel which are at present wasted.

While, on account of the magnitude of the subject and the amount of investigation involved, it is not possible at present to submit any report, it may be mentioned that information has been sought as to the amount of fuel consumed and the corresponding power developed in such official publications as the Report of the Royal Commission on Coal Supplies in 1905, the Census of Production for the year 1907, and the Returns published annually by the Home Office for Mines and Quarries, and various Shipping and Customs Reports. But although, from such sources, fairly accurate figures can be obtained for the amount of coal used annually for industrial purposes and shipping, the corresponding figures of power produced are not obtainable from any published returns so far as can be ascertained.

The average figure of 5 lb. of coal per horse-power-hour which was given in the Report of the Royal Commission on Coal Supplies in 1905, was we believe, deduced from returns from a number of typical industrial concerns where information could be obtained, and it is probable that this estimate did not exaggerate the actual coal consumption per horse-power-hour at that time.

In view of the impossibility of obtaining accurate returns of fuel consumption per horse-power hour from the whole of the power users in this country, it has been decided to investigate the matter by asking for detailed returns from typical factories in various trades and in different districts throughout the country, selected by members of the Sub-Committee who have special knowledge of particular trades.

Special memoranda are in course of preparation on questions of organisation of power production for industrial and transport purposes, the use of large turbine and gas engines, and other important aspects of the power question.

E.

Domestic Fuel Sub-Committee.—Mr. E. D. SIMON (*Chairman*), Mr. A. H. BARKER, Professor H. B. DIXON, Professor W. W. HALDANE GEE, Professor W. P. WYNNE, and Mr. H. JAMES YATES.

The amount of coal actually consumed for domestic purposes in the United Kingdom probably does not fall far short of 36,000,000 tons per annum—nearly one-fifth of the total consumption for all purposes in the kingdom. To this would have to be added the "coal equivalent" of the gas and electricity consumed for domestic purposes, if a correct estimate of the total domestic coal consumption is to be made. The Royal Commission of 1905 estimated that 50 per cent. of the coal consumed for domestic purposes might be saved by the installation of better appliances, so that there is clearly a vast field for economy.

The whole question of domestic uses of fuel bristles with difficulties and complications. In the first place, it is necessary to discriminate between fuel or energy consumed in the kitchen for cooking and other similar purposes, and that applied for the heating of ordinary living-rooms.

In the vast majority of the houses inhabited by the artisan population the kitchen fire or stove is the only place in the house where fuel is burnt; also in better-class houses it is only in the kitchen that fuel is burnt daily throughout the whole year. Hence it would appear that the kitchen is responsible for the greater part of our annual domestic fuel bill, and, therefore, the question of the relative efficiencies of kitchen ranges, gas and electric cookers, and hot-water supply apparatus assumes considerable importance.

Again, the selection or recommendation of particular means or apparatus for domestic heating cannot always be based simply upon the question of thermal efficiency, because it also involves considerations of a physiological and even of a psychological character. Thus for example, systems of central heating which have been recommended on grounds chiefly of thermal efficiency, and which are so universally used in America and on the Continent, are not usually acceptable to the average Englishman, who undoubtedly prefers to be warmed by the radiation from a bright fire.

This being so, the Sub-Committee feels that it will be wise to recognise at the outset that there is probably no single solution of the domestic heating problem which is likely to be universally adopted within any measurable period of time; and that, therefore, it should preferably concentrate its efforts upon questions of more immediate practical importance.

It will be generally agreed that any reform in domestic fuel consumption should aim at achieving one or more of the following objects, namely:—

1. Actual reduction in cost of domestic heating, either in the form of direct saving of fuel or labour, or both;
2. Mitigation or abolition of the domestic smoke nuisance; and
3. Better hygienic conditions in living apartments generally.

The Sub-Committee can perhaps best discharge its duties by considering how far the various systems now available for domestic heating fulfil such requirements, and how they may severally be installed and operated to the best advantage.

In order to do this the Sub-Committee has arranged for experiments to be carried out with the object of determining how to produce in a given room suitably warm and healthy conditions at a minimum cost and with a minimum production of smoke, and how such conditions may be defined for any particular room. Also, experimental work is being carried out upon the relative efficiencies of coal fires, gas fires, electric heaters, and the like.

Inasmuch, however, as in this country the use of the open coal fire will probably continue for some time to come, and as there are undoubtedly great economies to be immediately realised by the wider adoption of improved fire-grates, the Sub-Committee will pay special attention to the question of improvements in the construction and installation of such grates, to which the attention of architects, builders and the public generally ought to be drawn.

Arising out of the present extensive use of solid fuel in domestic fires, the Sub-Committee will also consider the important question of the prospects of substituting for raw coal some form of carbonised fuel (semi-coke or coke). There can be no doubt but that if such a substitution could be effected, without either increasing the domestic coal bill or involving some other disadvantage, not only would there be a great addition to the amount of valuable by-products annually obtained from coal consumed in the kingdom, but also the smoke nuisance in our large centres of population would be materially reduced.

Work on these lines is being carried out in the Department of Heating and Ventilating Engineering at the University College, London, at the Municipal School of Technology, Manchester, and at the Department of Chemical Technology at the Imperial College of Science and Technology, London.

FUEL ECONOMY ON THE NORTH-EAST COAST AS A RESULT OF ELECTRIC POWER SUPPLY.*

By R. P. SLOAN.

ELECTRIC power supply, though of comparatively recent development, has already had a marked effect upon the industries of the North-East Coast, for example:—

1. A great saving of coal and reduction of smoke has resulted. There is now, apart from the power companies, practically speaking, no coal burned on the Tyne for power purposes, except by the railways and chemical factories and some collieries. The Tyne shipyards and engineering works may be said to have adopted electricity to the exclusion of all other forms of motive power.

2. The application of electricity to all new uses has been facilitated:—

(*a*) Many collieries depend entirely upon electricity supplied from the Newcastle and Durham electric power companies' combined system for all their power requirements.

(*b*) As a result of the adoption of electric traction, the suburban railway traffic facilities of Newcastle are more ample than those of any other town of similar size.

(*c*) Electricity has been applied to freight haulage on the Newport-Shildon line (and this is the first real example of heavy freight haulage by electric locomotives in this country).†

(*d*) Electricity has been applied with particular success to drive rolling mills and colliery winders, and for other purposes requiring the concentration of a large amount of power on one shaft.

3. New industries have been established in the district purely because of the cheap power available.

4. Extensive utilisation has been made of the waste heat and gases existing in the area for the production of electrical energy. In this regard the district occupies a unique position owing to the extent to which its power requirements have been met by electricity produced as a by-product of two of its largest industries—the making of pig-iron and the making of coke.

5. Several small, and therefore uneconomical, generating stations—municipal and company—have been shut down, and the electrical distribution systems which they supplied have been connected up to the power supply companies' system.

The problem of power supply in any district is so completely governed by local conditions that it may be permitted at the outset to summarise the nature and extent of the staple industries of the North-East Coast. The table below does this in convenient form.

North-East Coast figures represent respectively and approximately one-fifth, one-third and one-half of the nation's output.

It was early realised that the more completely the electrical wants of the whole community could be met, the more cheaply could a supply of electricity be given and the more stable would the electric supply industry become. Our engineers therefore proceeded to design the system so as to be capable of producing current at a minimum cost and of providing a satisfactory supply for all purposes—power, traction, lighting and electro-chemical and similar processes.

The extent of the area (1,400 sq. miles) necessitated the generation of electricity at a pressure and in a form facilitating transmission over long distances, while the nature of the market to be catered for made it essential that the current should be produced as cheaply as possible. This, in turn, involved the use of extensive sites with ample coal and water facilities for the main coal-fired power stations, which were erected to deal with such portions of the load as could not be supplied with electrical energy generated by waste heat. From the two main stations situated on the River Tyne the transmission and distribution networks extend into and through the City of Newcastle-upon-Tyne, northwards to Blyth and beyond, and eastwards along the River Tyne, through Wallsend to North Shields. On the south bank of the Tyne the system extends southwards through the county of Durham from the coast to Consett and Bishop Auckland on the west, and then joins up with the system of the Cleveland and Durham Electric Power Company, whose area covers the South Durham and Yorkshire districts, including the Cleveland mining district, Stockton-on-Tees, Middlesbrough, &c. The distance between the northern and southern extremities of the transmission system is 70 miles, and it is now possible to obtain electricity on the same system as regards frequency and voltage throughout practically the whole of the area embraced in the scheme. The main transmission and distribution system is a three-phase system with a frequency of 40 cycles per second, and the working pressure is 20,000 volts.

The capacity of plant installed represents about one-ninth of the total plant installed in public supply stations in the United Kingdom, but as the North-East Coast power companies are working at a more constant load—*i.e.*, a better "load factor"—the electricity actually generated is about one-fifth. The total horse-power at present being supplied is 343,000 h.p.

Though the extension of the power supply system has been rapid, its development and the growth of its profit-earning capacity were considerably delayed by the work which had to be done from time to time, and the sacrifices that had to be made, to secure uniformity of system. Unfortunately with each amalgamation, or extension of area, considerable alterations had to be effected in the system of the new undertaking concerned. For example, the system of the Newcastle-upon-Tyne Electric Supply Company—the pioneer company—the first instalment of which was laid down in 1899, is a three-phase 40-cycle system. That of the Durham Collieries Electric Power Company, the operation of which the Newcastle-upon-Tyne Electric Supply Company took over in 1907, was a 50-cycle three-phase system, while the Tees area of the Cleveland and Durham Electric Power Company, where supply was begun in January, 1906, was originally designed for 25 cycles. The same company's Consett and Bishop Auckland Stations were designed, one to give three-phase 25-cycle current, the other two-phase 50-cycle current. It will be appreciated that these alterations (involving in some cases the complete re-design of system) have necessarily delayed development, but it was considered best to secure uniformity, even at some sacrifice of time and money. All these other systems were sanctioned and commenced some time after the original Newcastle system was laid down.

The work of making the systems uniform has been completed, and, in addition, several small and therefore uneconomical generating stations have been shut down. Throughout the area embraced in the scheme there are now only three public supply stations not conforming to the standard system and frequency, viz., those of the Sunderland, South Shields and Darlington Corporations.

The local conditions governing power supply in the district are:—

1. The low price of coal, which would enable the manufacturers to produce power themselves at relatively low rates.

2. The fact that the manufacturers' works are mostly of considerable size, *i.e.*, their individual electrical requirements are large. (A factor invariably of vital importance in the production of cheap current, whether by a public company or a municipality or by a private manufacturer, is the capital expenditure per useful horse-power of plant. This decreases as the size of plant grows, while the running efficiency at the same time increases.)

3. The existence of large quantities of potential energy in the form of waste heat and combustible gas.

NORTH-EAST COAST INDUSTRIES.

	Population at Census, 1911.	Coal Mined, 1913.	Coke Made, 1913.	Ironstone Mined, 1913.	Pig-Iron Made, 1913.	Merchant Shipping Built, 1913.
		Tons.	Tons.	Tons.	Tons.	Net tonnage.
N.-E. Coast industrial area ..	2,300,000	56,352,218	7,500,000	6,010,836	3,869,214	625,280
United Kingdom	45,211,888	287,430,473	20,529,732	15,997,328	10,260,315	1,231,921
Ratio—		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
N.-E. Coast / United Kingdom ..		19.6	36.5	37.5	37.7	51.0

It will be seen that in coal, iron and shipbuilding the

* Paper read before Joint Meetings of Sections B and G of the British Association at Newcastle, Sept. 8, 1916.

† See ENGINEERING, CI, pp. 495, 521.

The first and second conditions have been met by the power companies, in erecting their main generating stations: (a) by taking full advantage of the best coal and water facilities available; (b) by installing plant of a capacity much in excess of that which any individual manufacturer, however large, could adopt; (c) by catering for all classes of consumers, thereby securing a diversity of load with a resulting constancy of output and so utilising the plant installed to the best possible advantage. These factors, combined with the employment of a highly skilled technical staff and attention to numberless relatively minor details, have resulted in securing an efficiency of production much greater than that practicable to any manufacturer producing power merely as an auxiliary to his main business. This is, after all, an age of specialisation, and the production of electricity from coal at a minimum of cost presents opportunities for the highest technical skill and for unremitting vigilance.

Power supply in this district began on the north bank of the Tyne. It is natural, therefore, that its highest development was reached there earlier than in other parts of the district. By 1908 it could be said that there was not a single firm of shipbuilders or engineers on the north bank of the Tyne which did not take 95 per cent. of its power from the company. To-day the proportion is probably higher still. Even taking the whole area, it may now be said that, as regards the engineering trades as distinct from collieries and iron and steel works, from 75 to 80 per cent. of the power is supplied from the power companies' system.

The credit of electrifying the Newcastle suburban railways is, of course, due to the enterprise of the North-Eastern Railway Company; but the fact that they were the first important English railway to electrify a portion of their system, and that they purchased the necessary electricity from the power company, shows that the availability of cheap power is an advantage not only to manufacturers but to the public generally in facilitating the introduction of electric traction. Since the electrification of the Newcastle system the train service has been more than doubled and the schedule speed improved by 20 per cent. A comparison with other cities at home and abroad shows that no other town of similar population has so extensive an electrified railway system or so frequent a suburban service, and this has, of course, resulted in a large increase of travel.

The Newcastle and coast suburban railways were electrified more than ten years ago. More recently the North-Eastern Railway Company have applied electricity to a freight line, and have electrified some 50 miles of track on their Shildon-Newport route, which carries the heavy mineral traffic between the coalfields of South-West Durham and the blast furnaces and ironworks of the Middlesbrough district.

Few people realise that goods traffic forms the greater portion of the total business of the railways in this country, and is therefore of greater importance than the passenger traffic.

The electric locomotives, designed by Mr. Vincent Raven, the railway company's chief mechanical engineer, and built under his supervision at the railway company's works at Darlington, are each capable of hauling a load of 1,400 tons at a normal speed of 25 m.p.h. on the level, and of starting a train of the same weight on a 1 in 300 gradient.

No special generating station has been built, the whole of the current required being supplied by the power companies, whose existing mains are tapped at two points where they touch the railway.

The supply of electricity to coal mines—though the important colliery areas were not touched until some five years after power supply started on the Tyne—has now reached a high stage of development. It is estimated that, apart from the smaller colliery supplies, pits having an output of over 20,000,000 tons of coal per annum now depend upon the power companies for their power supply. The uses to which electricity is put include pumping, hauling, ventilating, winding, &c., and, as elsewhere, the simplicity and general advantage of the electric motor over all other forms of engine has made itself apparent. It is estimated, in the case of collieries, that at least 75 per cent. of the coal previously used for power purposes has been saved as a result of burning it at the economical generating stations of the power companies instead of each pit generating its own power; this is equivalent to a saving of at least 1,000,000 tons of coal per annum, apart altogether from the saving of coal resulting from the utilisation of waste heat, discussed later, and the saving of coal used for producing power for shipbuilding and engineering works and for the railways.

One of the most interesting features of the problem that had to be dealt with, and which it is not too much to say is also of considerable national importance, was the utilisation of the waste heat in the district. The counties of Northumberland and Durham and the North Riding of Yorkshire produce some 7,500,000 tons of coke per annum. The bulk of this used to be made in the old-fashioned beehive ovens, but during the last decade the retort type of oven has made rapid progress on account of its increased coke yield and the value of the by-products recoverable.

The waste heat from these ovens and from the blast furnaces and the exhaust steam from blowing engines in the Cleveland district form a considerable source of power.

The problem of the utilisation of this waste heat has been solved by the establishment of local generating stations where such surplus power is available. These plants feed into the main power companies' system and the stations work in parallel with the five main generating stations of the power companies. These local generating stations, or "Waste Heat" stations as they are commonly called, are run so that they each supply the maximum amount of energy possible—depending on the supply of waste heat or steam available—all regulating being done by the main power stations.

The power company need instal no spare plant in any of the waste-heat stations connected to its system, being able to meet any variation of load by means of its coal-fired stations, which also act as standby against any breakdown. Moreover, the power company, having a market for current many times greater than the output of any individual waste-heat station, is able to run such stations continuously at their maximum output capacity, so utilising completely all the current that can be produced therein; whereas it is impossible to conceive the power requirements of an individual coke-oven and colliery installation coinciding even approximately over 24 hours with the amount of gas or waste heat available.

The first waste-heat station was erected in 1905 by the Priestman Power Company, a subsidiary company formed jointly by the Priestman Collieries, Limited, and the Newcastle-on-Tyne Electric Supply Company, Limited, at Blaydon, in conjunction with new coke ovens then being erected by the Priestman Collieries, Limited, who were the first to see the advantages of co-operating with the power company.

There are now 11 waste-heat stations in operation in the North-East Coast area and, in a typical day's working of two such electrical generating stations the waste heat available is sufficient for the generation of an amount of power very considerably in excess of that required by the colliery owners. As a matter of fact, during the year 1915 these two stations alone turned out 40,000,000 units, of which only 10,000,000, or 25 per cent., were required for the working of the collieries, the remaining 30,000,000 units being delivered into the mains of the power supply company.

The total coal saving due to utilisation of waste heat in the North-East Coast now amounts to some 150,000 tons per annum.

This brief account of what has already been done on the North-East Coast will show the great economy which has been effected.

There can be no doubt that a proper appreciation of the enormous economies which may be effected by the avoidance of inefficient and wasteful separate power installations, and by the pooling, not only of all power requirements of all kinds, but also of all power-producing plants, into one interconnected power supply system in each industrial district, will be one of the most important factors in that general development of the country's industries which we are all hoping to see.

CADMIUM IN SPELTER.*

By WALTER RENTON INGALLS (U.S.A.).

FOR some purposes cadmium in spelter, even a small percentage of it, is deleterious. In spelter that is to be used for slush castings there is no doubt about it. In spelter for brass-making there is not the same certainty. For brass that is to be cast and machined, the adverse effect of cadmium is probably over-estimated, and it may not be adverse at all. For cartridge brass it is objectionable. In many cases where cadmium is objectionable it is not unlikely that there is hair-splitting about hundredths of a per cent. that is unnecessary. Military engineers and others who specify respecting brass should look carefully into this. The extraordinary differences in price that have lately prevailed, and still do to a less extent, between what in America are classified as high-grade, intermediate, brass-special and prime western (common) spelter do not look right.

The sampling of spelter is more or less of a haphazard process and has a bearing on this subject. American brass-makers follow a time-honoured practice of sampling a carload (about 50,000 lb. of spelter in 820 to 960 slabs) by drawing 10 slabs at random, and that practice has within a few weeks received the official endorsement of the American Society for Testing Materials. This was the outcome of controversies that have arisen over that matter. The following, from an editorial by the writer,† may be appropriately quoted here:—

"An interesting and entirely friendly controversy respecting the proper sampling of spelter recently arose between a well-known seller and an important brass manufacturer. The seller agreed to furnish two carloads of brass-special spelter guaranteed to contain not more than 0.6 per cent. of lead. The cars having arrived at the buyer's works, he drew 10 slabs from each, and finding the assays to exceed slightly the stipulated lead content, called for an adjustment. The seller sent out the agent of a prominent firm of public assayers to draw a new sample of 30 slabs per car. The buyers refused in advance to abide by the result of this.

"The issue was clear-cut. The seller claimed that he should be required only to deliver a carload of spelter whereof the average should conform to the guarantee, that in determining the average a large sample is more desirable than a small one, and that the conditions of producing spelter do not permit the insurance of uniformity in slabs except in the case of high-grade spelter.

"The buyer, on the other hand, contended that the conditions of brass-making, whereby the spelter is introduced into the melting-pots in small lots, necessitate uniformity, that its method of sampling during many years had been to draw only 10 slabs at random out of a carload, and that no other system would be safe for it.

"On none of these points have there been any official rulings. The specifications of the American Society for Testing Materials require as to sampling only that at least 10 slabs shall be drawn. In the contract between buyer and seller in this case, and probably in most of such cases, there was no contractual understanding.

"In the present instance the assays were made with the following results, those marked B being made by the buyer and those marked S by the public assayer acting in behalf of the seller:—

Party.	Car.	No. of Pieces.	Lead.	Iron.
			Per cent.	Per cent.
S	1	30	0.491	0.013
S	1	12	0.644	0.012
B	1	10	0.737	0.013
S	2	30	0.758	0.021
S	2	12	0.616	0.023
B	2	10	0.667	0.021

"The interesting thing about these assays was that in the case of Car 1 the 30-slab sample showed lower lead than the 10-slab, while in the case of Car 2 it showed higher. The discrepancy between the 10-slab and the 12-slab samples is also noteworthy. Manifestly there was irregularity in the composition of the slabs.

"As to the merits of the case there is a good deal to be said for each side. The brass-maker needs uniformity of the product he is buying. On the other hand, the smelter can hardly insure it by his present methods unless he be distilling high-grade ore that is already uniform. In distilling ore containing lead, the proportion thereof that goes over with the zinc is governed primarily by the temperature of the retort, which varies in different parts of the furnace. In drawing the spelter, the kettle into which it is received holds but a relatively small quantity, and the respective pourings from the same drawing may easily vary in composition, especially when lines are drawn so narrowly as they are as to lead content.

"Apparently there are two things that need to be done: (1) Sellers in offering a guarantee should specify as to whether it pertains to average of a carload or to any 10 slabs selected at random. (2) If buyers must have uniformity, smelters must ensure it by pouring and mixing their product in large pots or melting furnaces before casting the slabs to be marketed."

It need only be added that if the zinc smelter be obliged to guarantee practically every slab of his production, the consumer must pay for it; or if he must introduce the new process of re-melting and mixing, that also must be paid for.

Now, what are the conditions of the zinc smelter with regard to making spelter low in cadmium? His conditions are easy only when his ore is free from cadmium, but the only ore of that class produced in large quantity anywhere in the world is that of the Franklin mine of the New Jersey Zinc Company. That ore is also free from lead, and that company is the only one that can produce high-grade spelter by a single and simple process of smelting. The bulk of the world's zinc ore contains cadmium, and that metal, being metallurgically similar to zinc, distils with the zinc and contaminates the spelter, as also does lead.

In America brass-special spelter is made by reserving the first of the three daily drawings of spelter. This metal, having been distilled before the furnace has attained its maximum temperature, is relatively low in lead, but in it there is a concentration of cadmium, which, being volatile at a lower temperature than zinc, comes over chiefly in the first stage of the distillation. Theoretically it should be possible to control the temperature of the distillation so as to cut off both the cadmium-bearing spelter and the lead-bearing spelter, obtaining a high-grade spelter between; but practically that would be quite out of the question. It is, however, easily possible to get a high-grade spelter, low in cadmium, by the re-distillation of common spelter with proper control of the temperature and separation of the first distillate.

A good deal of the high-grade and intermediate spelter that America has sold to Great Britain at fancy prices during the last eighteen months has been re-distilled common spelter. Great Britain ought to have bought common spelter and re-distilled it herself.

In conclusion, it may be remarked that the electrolytic process of zinc extraction affords an easy means for the separation of cadmium. It should be borne distinctly in mind that the electrolytic process is going to be commercially applicable only under some limited specially favourable conditions and is not going to drive zinc smelting out of the world's arts. However, the electrolytic zinc production that is likely to endure should go a long way toward meeting the demand for high-grade spelter, and especially spelter low in cadmium. And, furthermore, inasmuch as the electrolytic cathodes have to be re-melted in large furnaces, the slabs cast therefrom should be more uniform in composition than those coming from the small tapping kettles of the retort furnace, the Bertha and Horsehead brands excepted.

* Paper read before the Institute of Metals, September 20, 1916.

† *Engineering and Mining Journal*, July 8, 1916.

THE EXPLOSIBILITY OF ACETYLENE.—A paper on this subject by George A. Burrell and G. G. Oberfell, issued by the Bureau of Mines, Washington, states that the authors' experiments showed that the smallest proportion of acetylene capable of propagating flame in a mixture of acetylene and air was 2.53 per cent. The largest proportion of acetylene capable of propagating flame in a mixture of acetylene and air was found to be about 73 per cent. Acetylene not mixed with air is explosive under a pressure of 3 to 5 atmospheres when an electric spark is passed through and when a platinum spiral is heated in it. The danger connected with the handling of calcium carbide in a mine is remote if reasonable care is observed in handling.